Lecture Notes in Networks and Systems 319

Tareq Ahram
Redha Taiar *Editors*

Human Interaction, Emerging Technologies and Future Systems V

Proceedings of the 5th International Virtual Conference on Human Interaction and Emerging Technologies, IHIET 2021, August 27–29, 2021 and the 6th IHIET: Future Systems (IHIET-FS 2021), October 28–30, 2021, France



Springer

Lecture Notes in Networks and Systems

Volume 319

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ISSN 2367-3370 ISSN 2367-3389 (electronic)
Lecture Notes in Networks and Systems
ISBN 978-3-030-85539-0 ISBN 978-3-030-85540-6 (eBook)
https://doi.org/10.1007/978-3-030-85540-6

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This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Preface

This book, entitled *Human Interaction, Emerging Technologies and Future Systems V*, aims to provide a global forum for presenting and discussing novel human interaction, emerging technologies and engineering approaches, tools, methodologies, techniques, and solutions for integrating people, concepts, trends, and applications in all areas of human interaction endeavor. Such applications include, but are not limited to, health care and medicine, sports medicine, transportation, optimization and urban planning for infrastructure development, manufacturing, social development, a new generation of service systems, as well as safety, risk assessment, and cybersecurity in both civilian and military contexts.

Rapid progress in developments in cognitive computing, modeling, and simulation, as well as smart sensor technology, will have a profound effect on the principles of human interaction and emerging technologies at both the individual and societal levels in the near future.

The book gathers selected papers presented at the 5th International Conference on Human Interaction and Emerging Technologies (IHIET 2021) and the 6th International Conference on Human Interaction & Emerging Technologies: Future Systems (IHIET-FS 2021), both conferences focusing on human-centered design and human interaction approaches which utilize and expand on the current knowledge of design and emerging technologies supported by engineering, artificial intelligence and computing, data analytics, wearable technologies, and next-generation systems.

This book also presents many innovative studies with a particular emphasis on emerging technologies and their applications, in addition to the consideration of user experience in the design of human interfaces for virtual, augmented, and mixed reality applications. Reflecting on the above-outlined perspective, the papers contained in this volume are organized into eight sections:

Section 1: Human–computer Interaction
Section 2: Human-centered Design
Section 3: Emerging Technologies and Applications
Section 4: Augmented, Virtual, and Mixed Reality Simulation

Section 5: Artificial Intelligence and Computing
Section 6: Wearable Technologies and Affective Computing
Section 7: Healthcare and Medical Applications
Section 8: Human Technology and Future of Work

Our appreciation also goes to the members of the scientific program advisory board who have reviewed the accepted papers that are presented in this volume.

Abbas Moallem, USA
Alberto Vergano, Italy
Anna Szopa, Poland
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We hope that this book, which presents the current state of the art in human interaction and emerging technologies, will be a valuable source of both theoretical and applied knowledge enabling the human-centered designs and applications of a variety of products, services, and systems for their safe, effective, and pleasurable use by people around the world.

August 2021

Tareq Ahram
Redha Taiar

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Human–Computer Interaction

Human and Machine Trust Considerations, Concerns and Constraints for Lethal Autonomous Weapon Systems (LAWS)

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Abstract. Trust and autonomous systems, especially weapon systems, could be the most difficult technological challenge facing defense industries, militaries, politicians, and the public because the algorithms have to be trusted. Furthermore, the operator, the military, defense industry, politicians and the public need to trust the system to also follow ethical and legal rules. This paper briefly describes the trust considerations, concerns and constraints regarding autonomous weapons systems and concludes with a brief description of the current development programs and projects by the various US military services.

Keywords: Artificial intelligence · Auditability · Autonomous · Confidence · Control controllability · Environment · Explainability · Human-machine · Interoperability · Lethal autonomous weapon system · Risk · Reliability · Safety · Scalability · Supervisability · Traceability · Transparency · Trust · Trustworthiness · Unmanned aerial vehicle · Unmanned ground system · Unmanned surface vehicle · Unmanned underwater vehicle

Human *trust* in technology is based on our understanding of how it works and our assessment of its safety and reliability. To *trust* a decision made by an algorithm, we need to know that it is *reliable and fair*, that it can be *accounted for*, and that it will *cause no harm*. We need assurance that it *cannot be tampered with* and that the system itself *is secure*. We need to *understand the rationale behind the algorithmic assessment, recommendation or outcome*, and be able to *interact with it, probe it – even ask questions*. And we need assurance that the *values and norms of our societies are also reflected in those outcomes*…Moving forward, "build for performance" will not suffice as an AI design paradigm. We must *learn how to build, evaluate and monitor for trust*. [1] [italics by author].

The above quote describes the challenges that industry, such as IBM, and others have with artificial intelligence and autonomous systems, and helps identify technical, legal and ethical aspects of the problem. Much of the discussion regarding Lethal Autonomous Weapon Systems (LAWS) in the media, academia, human rights organizations, and among governments have been about legal concerns of employing LAWS. This paper highlights considerations, concerns, and constraints regarding trust between the human-machine "interface" and LAWS.

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 3–10, 2022.
https://doi.org/10.1007/978-3-030-85540-6_1

What is trust? The National Institute of Standards and Technology (NIST) is tasked to provide guidance on standards for technology in the US. Trust can have a simple definition, such as "The confidence one element has in another that the second element will behave as expected." [2] Trust can also be defined in a very technical manner such as the 17 technical concerns that can negatively affect products and services: "(1) scalability, (2) heterogeneity, (3) control and ownership, (4) composability, interoperability, integration, and compatibility, (5) 'ilities' (non-functional requirements), (6) synchronization, (7) measurement, (8) predictability, (9) specific testing and assurance approaches, (10) certification criteria, (11) security, (12) reliability, (13) data integrity, (14) excessive data, (15) speed and performance, (16) usability, and (17) visibility and discovery." [3] In addition to these 17 technical trust concerns, two additional non-technical concerns are included: insurability and risk management. [3] In the case of military autonomous systems, insurability is not relevant, but risk management certainly is.

At the end of the day, trust is earned and cannot be assumed. A NIST Internet of Thinks (IoT) paper ends with a cautionary note:

For instance, *humans are prone both to over-trusting and to under-trusting machines* depending on context. *Challenges also exist for measuring the performance of human-AI teams*, conveying enough information while *avoiding cognitive overload*, enabling humans and machines to *understand the circumstances in which they should pass control between each other, and maintaining appropriate human engagement to preserve situational awareness and meaningfully take action when needed.* [4].

Trust is further complicated when the machine does not work properly and military or technical personnel attempt *ad hoc* repairs and the results could be disastrous:

If the technology employed is unstable, personnel may avoid using the equipment or may develop *ad hoc* and informal fixes to the perceived weaknesses… The resulting gap between senior leaders' performance expectations and actual performance introduces another source of uncertainty into senior leaders' understanding of the combat situation. [5].

These challenges also describe the challenges military personnel will face as autonomous systems are phased into operational units. As militaries around the world develop and use various autonomous systems and as these systems become weaponized, military personnel will have to trust these systems. Some NIST definitions will provide a common lexicon to use in this paper:

Risk. A measure of the extent to which an entity is threatened by a potential circumstance or event, and typically is a function of: (i) the *adverse impact, or magnitude of harm*, that would arise if the circumstance or event occurs; and (ii) *the likelihood of occurrence* [6].

Trustworthiness. The attribute of a person or enterprise that provides *confidence* to others of the *qualifications, capabilities, and reliability* of that entity to perform specific tasks and fulfill assigned responsibilities [6].

Trustworthy Information System. An information system that is believed to be capable of *operating within defined levels of risk* despite the *environmental disruptions, human errors, structural failures, and purposeful attacks* that are expected to occur in its *environment of operation* [7].

Weapon System. A combination of one or more weapons with all related equipment, materials, services, personnel, and means of delivery and deployment (if applicable) required for self-sufficiency. [7].

In general, trust involves risk because it involves depending on another: When a person uses an autonomous system, the individual assumes the system will perform as designed and not have an unintended engagement. In other words, the system has expected results: positive outcomes and negative avoidance. In reviewing the literature on artificial intelligence, trustworthiness, reliability, risk, safety, challenges, control and related synonyms are used to describe the trust relationship. The antonym of these terms are also used to describe outcomes such as "untrustworthy suppliers, insertion of counterfeits, tampering, unauthorized production, theft, insertion of malicious code, and poor manufacturing and development practices." [6].

Ethical and legal considerations of trust are primary to public policy discussions. For example, former President Trump's Executive Order on promoting trust with AI in the Federal Government highlighted on the following:

Agencies must therefore design, develop, acquire, and use AI in a manner that fosters *public trust and confidence while protecting privacy, civil rights, civil liberties, and American values, consistent with applicable law*… [8].

The *National Artificial Intelligence Research and Development Strategic Plan: 2019 Update* offers an example that covers technological and the political dimensions: "Beyond being safe, secure, reliable, resilient, explainable, and transparent, *trustworthy AI* must preserve privacy while detecting and avoiding inappropriate bias." [9] The NIST concentrates on technical aspects of trustworthiness in implementing trust in AI to meet the intent of the political leaders.

Europe is also involved in trust and artificial intelligence. For example, the European Commission defines "trustworthy AI" in terms of "three components: (1) it *should be lawful*, ensuring compliance with all applicable laws and regulations; (2) it *should be ethical*, demonstrating respect for, and ensuring adherence to, ethical principles and values; and (3) it *should be robust*, both from a technical and social perspective, because, even with good intentions, *AI systems can cause unintentional harm.*" [10] The European Commission (EC) guidelines further elaborate that in order to ensure that artificial intelligence is trustworthy, it must "ensure that the development, deployment and use of AI systems meets the seven key requirements: (1) human agency and oversight, (2) technical robustness and safety, (3) privacy and data governance, (4) transparency, (5) diversity, non-discrimination and fairness, (6) environmental and societal well-being and (7) accountability." [10] The EC guidelines deal with technological and political dimensions.

Interest in artificial intelligence is exploding in global scientific, policy, and public interest arenas. For example, People's Republic of China (PRC) documents emphasize AI's technical aspects: "While vigorously developing AI, we must attach great importance to the potential safety *risks and challenges*, strengthen the forward-looking prevention and guidance on *restraint, minimize risk, and ensure the safe, reliable, and controllable* development of AI." [11] China's Ministry of Technology AI governing principles reflect the same concepts: "AI systems should continuously improve *transparency,*

explainability, reliability, and controllability, and gradually achieve auditability, supervisability, traceability, and trustworthiness." [12] The PRC documents emphasize the technical aspects of trustworthiness and not the legal and ethical aspects reflected by senior US political officials and the EC.

Just as military personnel will have to develop and maintain trust in LAWS, trust will also have to be established and maintained throughout the LAWS life cycle, that is, the design, development, deployment, maintenance and upgrades. Interestingly, the Department of Defense Directive (DODD) 3000.09 does not refer to positive outcomes as a design criterion. DoDD 3000.9 defines the goal of autonomous systems as to avoid negative outcomes ("unintended engagement" or experience a "loss of control") [13]. The lack of a reference in the DODD for a positive outcome for LAWS could be a weakness in the directive and should be reviewed to emphasize administration intent to ensure the weapon system performs as designed. More importantly, the military will have to consider the impact on trust when LAWS does *not perform as designed* or *does have an "unintended engagement" or experiences a "loss of control"* [13]; in other words, when LAWS does not perform as designed and breaks trust. By highlighting the unique trust considerations, concerns and constraints between the military person and LAWS, the DOD will be in a better position to provide employment guidance for these systems.

NIST's *Trust and Artificial Intelligence* (2021) explains in clear language the AI revolutionary challenge, why trust is so important and difficult to implement:

The artificial intelligence (AI) revolution is upon us, with the promise of advances such as driverless cars, smart buildings, automated health diagnostics and improved security monitoring. Many current efforts are aimed to measure system trustworthiness, through measurements of Accuracy, Reliability, and Explainability, among other system characteristics. While these characteristics are necessary, determining that the AI system is trustworthy because it meets its system requirements won't ensure widespread adoption of AI. It is the user, the human affected by, the AI who ultimately places their trust in the system. The study of trust in automated systems has been a topic of psychological study previously. However, Artificial Intelligence (AI) systems pose unique challenges for user trust. AI systems operate using patterns in massive amounts of data. No longer are we asking automation to do human tasks, we are asking it to do tasks that we can't. Moreover, AI has the ability to learn and alter its own programming in ways we don't easily understand. The AI user has to trust the AI because of its complexity and unpredictability, changing the dynamic between user and system into a relationship. Alongside research toward building trustworthy systems, understanding user trust in AI will be necessary in order to achieve the benefits and minimize the risks of this new technology [14].

These same issues described in the NIST document affect trust and LAWS. Next, we will examine each of the US military services' autonomous systems starting with the US Marine Corps, Navy, Army and ending with the Air Force.

The Commandant of the Marine Corps, General David Berger, stated in February 2021 that "the service needs to make some big changes in a few short years to stay ahead of China's growing military capability, but one of the biggest hurdles he sees is a lack of *trust* in the new unmanned and artificial intelligence systems he wants to invest

in… 'We have programs right now, capabilities right now that allow for *fully automatic processing of sensor-to-shooter targeting, but we don't trust the data.* And we still ensure that there's human intervention at every [step in the process]. And, of course, with each intervention by humans we're adding *more time, more opportunities for mistakes to happen*, time we're not going to have when an adversary's targeting our network… We have the ability for a quicker targeting cycle, *but we don't trust the process.*'" [15].

The March 2021 Department of the Navy's *Unmanned Campaign Plan* describes its vision for the Navy as to "make unmanned systems a *trusted* and sustainable part of the Naval force structure, integrated at speed to provide *lethal*, survivable, and scalable effects in support of the future maritime mission." [16] Additionally, the Chief of Naval Operations (CNO) released his AI plan [17] that states the following:

> [u]nmanned platforms play a vital role in our future fleet. Successfully integrating *unmanned platforms—under, on, and above the sea*—gives our commanders better options to fight and win in contested spaces. They will expand our *intelligence, surveillance, and reconnaissance advantage*, add *depth to our missile magazines*, and provide *additional means to keep our distributed force provisioned*. Furthermore, moving toward smaller platforms *improves our offensive punch* while also providing affordable solutions to grow the Navy [17].

The plan calls for the Navy to develop, test and deploy unmanned systems to perform the "*dull, dirty and dangerous*" missions. Some of the systems in development are the MQ–25A Stingray (unmanned carrier-based refueling tanker); Overlord Unmanned Surface Vehicles (USVs); Sea Hunters; and Ghost Fleet Overlord. [18 & 19] The USMC is developing and testing systems such as the Supply Glider effort that DARPA has assisted with: "heavy-duty cardboard gliders which can deliver supplies and then disappear in a span of days" and although they are re-useable, they "are designed to be expendable and biodegradable." These small gliders can be released by aircraft to deliver critical suppliers to a precise location defined by ground troops. The Supply Glider's features avoid the problem of inaccurate deliveries, "a need to recover the system after deployment" as well as "the cost of resupply systems (parachute or UAVs) that must be retrieved as well as other challenges of returning logistical systems such as batteries that displaces payload capacity, as well as launch/land infrastructure." [20] Cardboard UAVs would be difficult to detect and to shoot down, and could be designed to deliver warheads. In effect, they would be inexpensive stealth systems. Instead of a transport aircraft being a logistical system to support ground troops, it could also deliver a massive strike via an airdrop.

The US Army is developing the *Advanced Targeting and Lethality Automated System (ATLAS)* that "will use artificial intelligence and machine learning to give ground-combat vehicles autonomous targeting capabilities" allowing weapon systems to "acquire, identify, and engage targets at least 3X faster than the current manual process" [21]. Moving to a higher level of operations, *Project Convergence* is a US Army program that connects any sensor to the best shooter. Project Convergence has two sub-projects: an automatic target recognition AIs that are "machine learning algorithms processed the massive amount of data picked up by the Army's sensors to detect and identify threats on the battlefield, producing targeting data for weapon systems to utilize." The AI fire

control, *FIRES Synchronization to Optimize Responses in Multi-Domain Operations or FIRESTORM*, incorporates "targeting data from the other AI systems, FIRESTORM automatically looks at the weapons at the Army's disposal and recommends the best one to respond to any given threat." [22] Elements of ATLAS and Project Convergence were tested in late 2020 at Yuma proving grounds.

Other countries are developing their own UGVs such as "AI-driven and tracked combat UGVs like Bogomol (Belarus), Vikhir (Russia), Ripsaw (USA), Giant Tiger (China)" and "[r]esearch indicates that 33 percent of future warfare will be unmanned and deployment of Unmanned Combat Ground Vehicle (UCGV) can provide a tactical advantage and technological superiority in the war." [19].

In response to great power competition in air, land, sea, space, and cyberspace domains, the USAF S&T strategy declared "[r]ather than reacting to others' advances, the Air Force will set an unmatched pace. Instead of looking at where potential adversaries are heading, the Air Force scientific and technical enterprise will predict where adversaries cannot easily go and then ensure the Air Force gets there first" [23]. Using this framework under "Global Persistent Awareness," the USAF "must develop capabilities that provide on-demand awareness of adversary actions anywhere on the globe by securely gathering, processing, and fusing multiple types of *trusted* data from a large, diverse set of sensors" [23]. Under "Rapid, Effective Decision-Making" initiative, the USAF seeks to "realize the potential of artificial intelligence, the Air Force scientific and technical enterprise must push well beyond developed commercial applications in overcoming major challenges to effective military employment. These include unpredictable and uncertain physical environments, noisy and unstructured data from dissimilar sources, limited training data for machine learning, and the *high levels of trust required to support lethal combat operations*. Human effectiveness research in cognitive science, data presentation, and human-machine interfaces is also vital to optimize human-machine teaming performance." [23] Under "Complexity, Unpredictability, and Mass", the USAF plans to "augment its high-end platforms with larger numbers of inexpensive, low-end systems" with "[s]*warms of low-cost, autonomous air and space systems can provide adaptability, rapid upgradability, and the capacity to absorb losses that manned systems cannot*." [24] In other words, the USAF will need "to control large numbers of autonomous systems coordinated with traditional manned assets" and that "[a]rtificial intelligence advances are needed to achieve high levels of intelligence in small, embedded systems and execute complex missions with *trust*" [23].

The USAF autonomous systems seek to deliver additional firepower. The USAF autonomous weapon system's program name is the *Vanguard Program* and consists of three programs: *Skyborg, Golden Horde, and Navigation Technology Satellite 3 (NTS-3).* The *Skyborg Program* is a fleet of robotic "loyal wingmen"—a new class of autonomous drones—with 15 different potential mission sets. The Australian military has a robotic wingman that the USAF is considering. A US defense company, Kratos Defense & Security Solutions, has proposed the XQ-58A "Valkyrie" experimental drone for a mission separate from "loyal wingmen," and a Low-Cost Attritable Strike Demonstrator program, which has conducted several successful test flights [24].

The US Navy, USMC, and the US Army have focused on developing logistics/supply autonomous systems before they develop autonomous weapon systems. The USAF has

taken a different approach to the development of unmanned systems by concentrating on creating autonomous weapon systems that augment the firepower of fighter aircraft [25]. One implication of the USAF strategy is to reduce the number of pilots needed for hazardous missions and, eventually, to remove pilots from extremely high-risk missions. While the US Navy is developing an autonomous air refueling tanker, the USAF has not mentioned going down this path [25]. The USAF has discussed developing and testing unmanned aircraft that "could carry elements of the future Advanced Battle Management System (ABMS), a command and control, communications, and data-sharing network architecture." [26].

The *Golden Horde* program "is envisioned as a collection of small networked expendable drones integrated by datalink radios and collaborative behaviors" that can use "data links to communicate, choose targets (based on pre-programmed algorithms) and then coordinate strikes against an array of targets, independently from the human pilot." The program also is testing "a 'swarming' munitions concept" that "allows for collaborative weapons that can share target information and autonomously coordinate their strikes after launch [which] could help maximize target damage and compensate for weapons lost in flight due to enemy defenses or other factors." [27].

NTS-3 is designed to be a non-GPS "position, navigation, and timing (PNT) capability." [28] Finally, another Air Force autonomous program is R2D2 (named after the droid from Star Wars) which is "to provide a more robust autonomous air-to-air capability." [26].

In summary, this short paper on trust and lethal autonomous weapon systems exposed challenges, concerns and constraints that affect the employment of autonomous systems. The primary problem is translating trust into an algorithm that functions throughout the life cycle of a military autonomous system. A secondary problem is ensuring trust remains as AI develops, learns, and matures over time. A tertiary problem is ensuring that all systems and sub-systems and their respective algorithms are complaint with NIST trust standards, but also when they interact with other systems. As the various military worldwide build autonomous systems, including LAWS, the technical, the legal and the ethical challenges, concerns and constraints will become the modern Gordian knot that will not be solved by simply cutting it. Ensuring trust—not over-trust and not under-trust—is the crucial task that technologists, military personnel, politicians and the public must solve as autonomous weapon systems become more complex, more lethal, and more ubiquitous.

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A Multimodal Approach for Early Detection of Cognitive Impairment from Tweets

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Abstract. The proposed approach can filter, study, analyze, and interpret written communications from social media platforms for early detection of Cognitive Impairment (CI) to connect individuals with CI with assistive services in their location. It has three novel functionalities. First, it presents a Big Data-centric Data Mining methodology that uses a host of Natural Language Processing and Information Retrieval approaches to filter and analyze tweets to detect if the tweets were made by a user with some form of CI – for instance, Dementia. Second, it consists of a string-matching functionality that uses the Levenshtein distance algorithm and Fuzzy matching to score tweets indicating the degree of CI. Finally, the framework consists of a text mining approach for detecting the geolocation of the Twitter user so that, if the user is cognitively impaired, caregivers in that area could be alerted and connected to them to facilitate early-stage care, services, therapies, or treatment.

Keywords: Natural language processing · Data mining · Big data · Elderly population · Cognitive impairment · Dementia · Geolocation · Twitter

1 Introduction

Dementia, a form of Cognitive Impairment (CI), develops slowly, but it is common in the rapidly increasing elderly population, which currently stands at 962 million globally [1]. At present, there are around 50 million people worldwide who have Dementia, and this number is projected to double by 2030 [2]. The costs of looking after people with Dementia and other forms of CI are a global concern. In the United States alone, these costs are estimated to be around USD 355 billion in 2021 and are projected to rise to about USD 1.1 trillion by 2050 [3]. Thus, early detection of Dementia and other forms of CI is essential for providing assistive care and services to reduce the associated long-term healthcare and caregiving costs. Over the last few years, social media platforms have evolved and transformed into 'virtual' spaces via which people from all demographics communicate with each other to form their social support systems [4] and develop 'online' interpersonal relationships [5]. Recent research shows that people use different social media platforms to seek support, share information, and communicate with others when they face various forms of CI and are in the early stages of the same [6, 7].

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 11–19, 2022.
https://doi.org/10.1007/978-3-030-85540-6_2

Early diagnosis of CI, such as Dementia, has several benefits [8] such as improved quality of life, probability of pharmacological and non-drug treatments to have maximum effect, delaying transition into care homes, better treatment of dementia-related depression, reduced behavioral disorders and increased independence during activities of daily living. Communication difficulties, both in oral and written communications, are considered one of the earliest symptoms of CI [9]. This paper presents a brief review of related works and gives the rationale for the new approach in Sect. 2. Section 3 presents the multilayered framework as the solution. Section 4 shows how this framework was implemented using a data science tool and discusses the obtained results of detecting CI from tweets, followed by the concluding remarks in Sect. 5.

2 Literature Review

Cavedoni et al. [10] presented a virtual reality-based approach for detecting CI in the elderly. The paper also outlined the approach of studying the evolution of CI over time. In [11], the work mostly involved discussing various approaches for diagnosing mild cognitive impairments in the elderly. An activity recognition and analysis-based framework for detecting mild cognitive impairment in the elderly was presented in [12]. In [13], the authors evaluated the efficacy of multiple assessments on the same day to accurately detect CI in patients with Alzheimer's. A Plasma microRNA biomarkers-based approach was proposed by Sheinerman et al. [14] to detect various forms of mild cognitive impairment in the elderly. The Mini-Mental State Examination is another approach for detecting CI in the elderly that is widely used to analyze the cognitive abilities of individuals [15]. To address the limitations of MMSE, which is specifically related to the overestimation of the results, the Korean Dementia Screening Questionnaire (KDSQ) was developed. It is a specific set of questions, and this evaluation can be conducted by anyone, even without specialized skills related to the detection of any form of CI [16]. Despite these recent advances in this field, early detection of CI, such as Dementia, remains a challenge. This is primarily because the methodologies for detecting CI based on behavior recognition and analysis require the elderly to either have wearables on them or familiarize themselves with new technology-based gadgets and devices, which most elderly are naturally resistive to. Thus, finding solutions for early detection of CI by capturing the early symptoms and relevant signs in a more natural, relaxed, and elderly-friendly way is much needed. We address this challenge by developing a multilayered framework, at the intersection of Natural Language Processing with several other disciplines, that contains methods for processing such early symptoms and relevant signs associated with CI, such as Dementia. The framework consists of the functionality to filter, study, analyze, and interpret written communications from social media platforms to detect if these communications were made by users with some form of CI, such as Dementia.

3 Proposed Approach

This framework has multiple layers. Each layer is equipped with a distinct functionality that serves as the foundation for the development and performance of the subsequent

layer. We used data from Twitter, a popular social media platform, for development, implementation, and testing all these layers. The first layer performs data gathering, preprocessing, content parsing, text refinement, and text analysis to detect tweets that could have been made by a user with some form of CI. This layer also consists of the methodology to perform intelligent decision-making for filtering tweets to eliminate advertisements and promotions.

The second layer implements a methodology to score the tweets obtained from the first layer to determine the extent of CI. It uses the Levenshtein distance algorithm [17] to implement a scoring system based on the degree of string matching by calculating the linguistic distance between the tweet and a user-defined bag of words. This layer also contains a user-defined threshold for this scoring system, allowing filtering of tweets as per their scores compared to this threshold. All the tweets which receive a score greater than or equal to this threshold are retained in the results, and the other tweets with scores less than this threshold are eliminated. The third layer consists of the methodology to detect the user's geolocation whose tweets indicated that they have some form of CI. This detection of geolocation is done based on the publicly available location data on respective Twitter user profiles.

We used RapidMiner [18], a powerful and versatile data science tool, to develop this framework. RapidMiner consists of a range of in-built functions called 'operators', which can be customized to develop such applications. A 'process' in RapidMiner is an application that uses one or more of its 'operators', which define different functionalities. RapidMiner also allows the development of new 'operators' with new or improved functionalities that can be made available to other users of this platform via the RapidMiner marketplace. The steps involved for the development of each layer are as follows:

First Layer:

1. Develop a bag of words model, which would act as a collection of keywords and phrases to identify tweets where people have communicated having CI.
2. Use the 'Search Twitter' 'operator' to search tweets that match the keywords and phrases from Step 1.
3. Perform filtering of tweets obtained from Step 2 to eliminate tweets that might be advertisements, promotions, or similar, which are not required for this study.
4. Identify and remove stop words from the tweets obtained from Step 3.
5. Filter out unwanted attributes from the RapidMiner results to retain only the tweets and other essential user information needed for this study.
6. Track the Twitter ID and username of each Twitter user by using the 'Get Twitter User Details' 'operator' from the list of tweets obtained after the filtering process. Here, we are using Twitter ID as the unique identifier for each Twitter user.
7. Integrate all the above 'operators' and develop a RapidMiner 'process' and set up a Twitter connection.

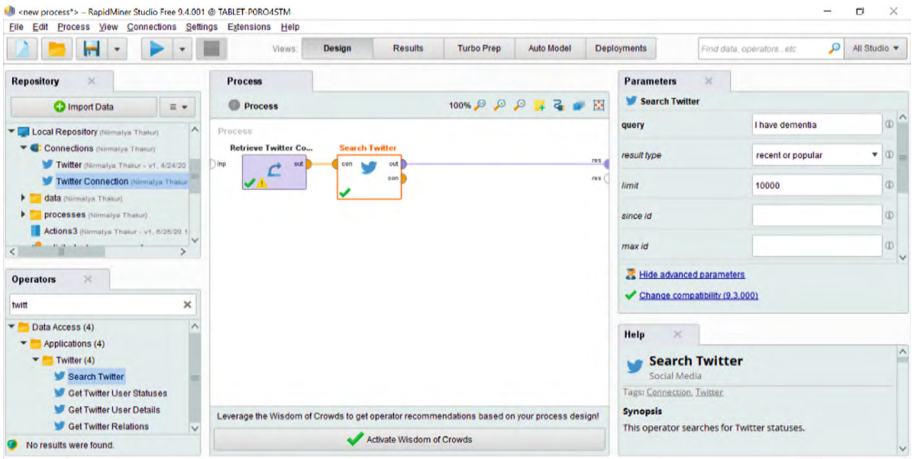


Fig. 1. RapidMiner 'process' showing the implementation of the first layer by using the 'Search Twitter' 'operator'

Second Layer:

1. Use the 'Get Twitter User Status' 'operator' to look up status updates by all the users identified in Step 6 of the first layer.
2. Use the 'Select Attribute' 'operator' to select only the text of the tweet (as a string) from the output of Step 1.
3. Using the 'Read Document' 'operator', set up a path to a file on the local computer that contains a set of keywords or phrases which indicate some form of CI, that would be used for checking similarity. It is recommended that this file is a .txt file.
4. Implement the Levenshtein distance algorithm using the 'Fuzzy matching' 'operator'. Provide Step 2 as the source and Step 3 as the grounds for comparison to this 'operator' to generate similarity scores based on string-comparison of each tweet.
5. Enable the advanced parameters of the 'Fuzzy matching' 'operator' to define the threshold value. This can be any user-defined value, and only those tweets that have a similarity greater than the threshold would be retained in the results.
6. Integrate all the above 'operators' and develop a RapidMiner 'process' and set up a Twitter connection.

Third Layer:

1. Use the 'Get Twitter User Details' 'operator' to look up publicly available location information associated with a Twitter account.
2. Configure this 'operator' to look up details using the Twitter ID associated with each account and supply the Twitter IDs identified in Step 6 of the first layer to this 'operator'.
3. Use the 'Select Attribute' 'operator' to filter out attributes from Step 1 that do not contain any location information.

4. Integrate all the above ‘operators’ and develop a RapidMiner ‘process’ and set up a Twitter connection.

To develop the above functionalities of our framework, we downloaded and installed several extensions from the RapidMiner marketplace. These include – Text Processing 9.3 by RapidMiner, Aylien Text Analysis 0.2.0 by Aylien Inc, and String Matching 1.0.0 by Aptus Data Labs. After that, we used the ‘Twitter’ group ‘operator’ available in RapidMiner Studio Core. This group ‘operator’ provides a collection of ‘operators’ – ‘Search Twitter’, ‘Get Twitter User Status’, ‘Get Twitter User Details’ and ‘Get Twitter Relations’ that can be used in any RapidMiner ‘process’. By following the above steps, we developed the RapidMiner ‘processes’, as shown in Figs. 1 and 2.

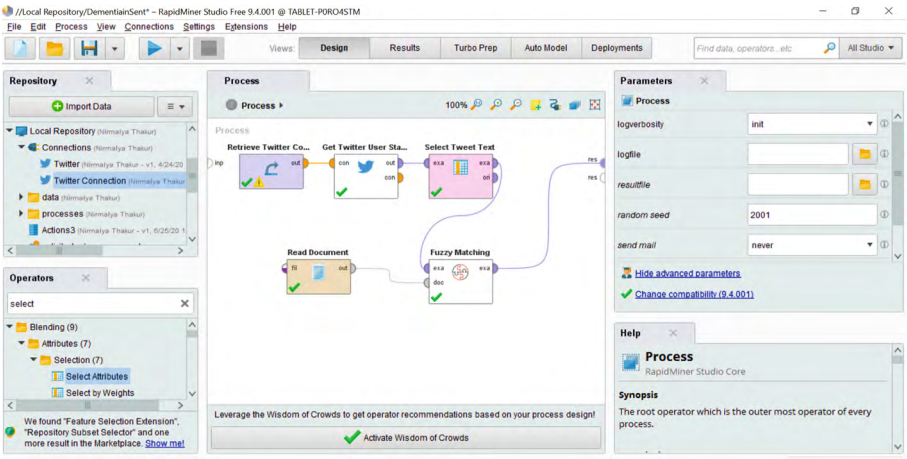


Fig. 2. RapidMiner ‘process’ showing the implementation of the second and third layer of the proposed framework

4 Results and Discussion

The bag of keywords consisted of various phrases and keywords where users directly communicated that they have some form of CI. In the first layer, we detect phrases that indicate the awareness, realization, and self-declaration of CI in tweets. These phrases included – “I have cognitive impairment”, “I have Dementia”, “I have Alzheimer’s”, “I have symptoms of cognitive impairment” and similar phrases or keywords. Figure 1 shows the ‘process’ that we developed in RapidMiner using the ‘Search Twitter’ ‘operator’ and one of these phrases – “I have Dementia”.

Row No.	String	Percentage ...
1	"RT @BoKnowsNews: Joe Biden tells press ahead of trip to NYC & PA for 9/11 memorial that this is a "solemn day" and the Biden campaign took..." "1304383713...	18
2	"RT @AnnieLinskey: "The Sept. 11 attacks targeted the cities that molded the two men" @mviser on how 9/11 impacted the presidential candidat..." "1304216079...	17
3	"RT @davecclarke: Republicans have been inundated by worried callers complaining about constant Biden ads with very few paid Trump responses..." "1304208...	16
4	"Trump said he misled on virus to instill calm. But he's governed with scare tactics, by @PhilipRucker\n\nhttps://t.co/Mqb2PRaRjQ" "1304205494509338626"	17
5	"The Sept. 11 attacks targeted cities that molded the two men, DC and NYC, reinforcing the clashing worldviews they now offer the electorate: Biden's embrace of ...	12
6	"Biden was on Amtrak when his wife called to tell him about the attacks on the World Trade Center. Trump was watching CNBC in a tower bearing his name, and ...	12
7	"NEW: Biden and Trump prepare to mark Sept. 11 — and are marked by it. \n\nMy latest, looking at where each man was nearly two decades ago, how their respo...	12
8	"Joe Biden at a fundraiser tonight, on debating Trump: "I hope I don't get baited into getting into a brawl with this guy...It's going to be hard because I predict he's g...	11
9	"Joe Biden spoke today to @starsandstripes, the military paper that days ago was slated to be shut down. \n\n"These 'forever wars' have to end," said Biden, who...	13
10	"Live Free or Die https://t.co/xNO4tXRtbl" "1304153974489124865"	25
11	"Biden on Trump: \"He talks about can you repeat four words in a row or whatever his little IQ test or dementia test he took, he doesn't understand duty, honor, servi...	24
12	"Joe Biden to @jaketapper on his health: "When it comes to Donald Trump versus me, just look at us. OK? Just look at us. Who seems to be in shape? Who's abl...	15
13	"'I don't want to jump up and down and start screaming, 'Death,'" President Trump says" "1304145971509690368"	20

Fig. 3. Some results from RapidMiner showing the data obtained from the first layer of the framework for a specific user, where the user-defined keyword or phrase provided as input to the 'process' was "I have Dementia"

The functionality of the 'operator' was customized to look for up to 10,000 recent or popular tweets because of the processing limitation of the free version of RapidMiner that we used. After implementing the approaches for data preprocessing and filtering for developing the first layer, the results obtained from this layer were analyzed. This is shown in Fig. 3. Next, the first layer's results were provided to the RapidMiner 'process' for the second layer, as shown in Fig. 2. The results obtained from this layer are shown in Fig. 4. After that, we followed the architecture of our framework to detect the location of these users by using the RapidMiner 'process' shown in Fig. 2. The result for one typical user is shown in Fig. 5.

Row No.	Id	Created-At	From-User	From-User-Id	Text	Retweet-Co...
8	1300592339887558661	Aug 31, 2020 8:32:32 PM EDT	Joe Bidens...	130050844659334...	I would say Donald Trump but I also have ...	0
9	1300592032264617985	Aug 31, 2020 8:31:18 PM EDT	Michael V	126729755253525...	RT @SpringSteps: It's conflicting watching ...	164
10	1300591709131165696	Aug 31, 2020 8:30:01 PM EDT	Ezekiel	127091198519914...	@JoeBiden I know you have dementia but, ...	0
11	1300591705096368129	Aug 31, 2020 8:30:00 PM EDT	John Sirko	834751173903122...	@TomiLahren I can't imagine the low num...	0
12	1300591479522500618	Aug 31, 2020 8:29:07 PM EDT	Stac	117173276683420...	RT @stac_45: @PatsyHennessey @Chow...	1
13	1300591456906817537	Aug 31, 2020 8:29:01 PM EDT	Stac	117173276683420...	@PatsyHennessey @ChowPuppy1 @real...	1
14	1300591443560415233	Aug 31, 2020 8:28:58 PM EDT	Aspen	1647796430	@KAMMAR_time @Sean_E_K @Barstool...	0
15	1300591395368042497	Aug 31, 2020 8:28:47 PM EDT	Volunteer L...	787318013817155...	RT @SpringSteps: It's conflicting watching ...	164
16	1300590972108144640	Aug 31, 2020 8:27:06 PM EDT	Salmon	834935054350548...	@the_real_P0tat0 @Zura1468 @No10750...	0
17	1300590898636558336	Aug 31, 2020 8:26:48 PM EDT	Lyn Caswell	125672176623758...	RT @SpringSteps: It's conflicting watching ...	164
18	1300590437967618049	Aug 31, 2020 8:24:58 PM EDT	NormanDe...	539721796	RT @SpringSteps: It's conflicting watching ...	164
19	1300590359446159365	Aug 31, 2020 8:24:40 PM EDT	Kristy	1625138857	@ljcljf3 @RoyalcoachPeg @SteveGuest @...	0
20	1300590114150572039	Aug 31, 2020 8:23:41 PM EDT	ERGA	793523630235803...	RT @SpringSteps: It's conflicting watching ...	164

Fig. 4. Some results from RapidMiner showing the data obtained from the first layer of the framework

In the context of these results, the 'Location' attribute is most important to us. Twitter allows every user the option to hide or protect different information associated with their account [19]. The above user had chosen to make all their account information public, so we could obtain their location. Similarly, the details of other users were tracked, and their locations were noted and compiled. Those users identified from the results

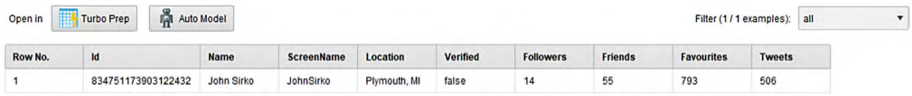


Fig. 5. Screenshot from RapidMiner's results terminal showing the results obtained from the third layer of the framework for a specific user

table shown in Fig. 4, who had chosen to hide or protect their information, specifically their location, were not included in this study. The location data obtained for all such user profiles would help the future scope of work on this project so that caregivers or medical practitioners in the same area could be connected to these users. We defined a very low threshold, threshold = 2, for the 'Fuzzy matching' 'operator' during the development of the second layer and its associated functionalities. This was to ensure that most of the tweets made by that specific user passed this threshold. This provided us the historical data of a person's tweeting history. In this context, the historical data are scores detecting the extent of CI of the user. This analysis is shown in Fig. 6 for one of the users. Such an analysis can have multiple uses, which include (1) study of tweeting patterns in terms of scores indicating the extent of CI associated with tweets; (2) detection of any sudden increase in these scores, which could indicate worsening of the CI symptoms or indicators suggesting immediate help, and (3) studying the degree of help provided by caregivers or medical practitioners looking after these older adults by observing the decrease of scores over time, just to name a few.

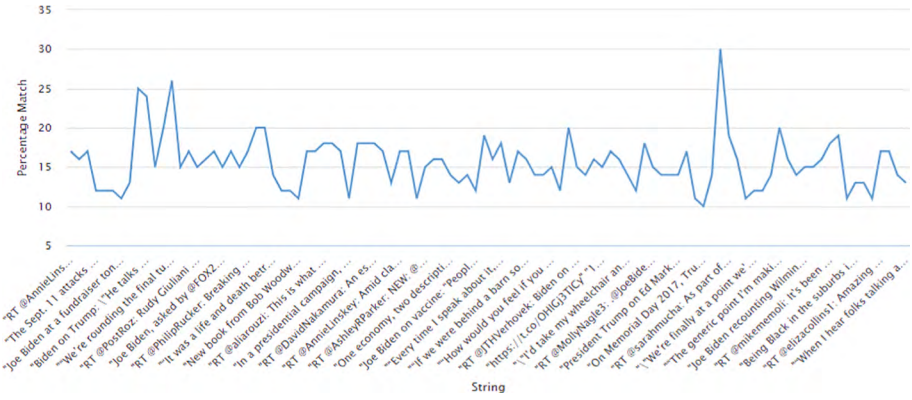


Fig. 6. Analysis of tweet scores (that indicate the degree of CI) for the tweeting history for one of the users identified by the first layer of the framework

5 Conclusion and Future Work

This paper proposes a multilayered, multifunctional, and interdisciplinary framework for the early detection of CI in the elderly from their tweets. The framework can also detect their geographic location. This location information can be used for connecting

them to assistive care and services in their geographic region to facilitate early-stage care, services, therapies, or treatment. The work explored the intersection of Natural Language Processing with Big Data, Data Mining, Data Analysis, Human-Computer Interaction, and Assistive Technologies. The framework uses data gathering, preprocessing, content parsing, text refinement, text analysis, and string comparison-based scoring of tweets by implementing the Levenshtein distance algorithm. It also consists of the methodology to interpret the degree of CI of a user based on a user-defined threshold value. As per the authors' best knowledge, no similar work has been done in this field yet. The results presented and discussed uphold the relevance and importance of this framework for early detection of CI, such as Dementia, in the elderly.

It also addresses the challenge of developing a cost-effective and easily implementable solution for early detection of CI that does not require the elderly to learn any new technologies or familiarize themselves with any new gadgets. Future work on this project would involve developing an approach to identify assistive care-based services in any geographic location, to connect those services to the elderly with CI in that region.

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A Formal Model of Availability to Reduce Cross-Domain Interruptions

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Abstract. The mutual awareness and availability across team members is essential for effective and efficient cooperation. Yet, interruptions in general and interruptions unrelated to the current domain and task in particular can lead to disturbing disruption. The literature on boundary management has great insight to offer with respect to organising and maintaining a balance between different life domains. In this paper we introduce a formal model of the semantic structure of life domains, grounded in the concept of integration and segmentation found in boundary theory. This formal model is based on simple set theory and relations. It is system unrelated but serves as a starting point for creating further implementation specific models in UML or other notations during the development process.

Keywords: Computer-supported cooperative work · Availability · Interruptions · Life domains · Formal model

1 Introduction

Effective and efficient teamwork requires that team members have adequate information about each other's work activities and results and are available for each other for communication, cooperation, and coordination [7]. However, this can also lead to interruptions. Interruptions in general and particularly interruptions that are unrelated to the user's current task domain can lead to disturbing disruption. Interruptions and their negative consequences have been an important topic in HCI research [13]. Recent research has shown that blocking distractions has a significant positive effect on focus and productivity [12].

In teamwork complete blocking is often not an option—team members often cannot completely disappear from the team. We therefore suggest to leverage on findings in boundary management where great findings have produced a lot of insight into how individuals structure and organise their roles and tasks into life domains as well as their availability and interruptibility within and across these domains [4, 6, 10].

The boundary management literature is abundant [e.g., 4, 6, 10, 14]. Therefore, it is necessary to boil it down to the main concepts that are relevant when analysing or designing interactive and cooperative systems that aim to help users managing their availability and awareness in teams while keeping interruptions to a minimum. In this paper we introduce a formal model of the semantic structure of life domains, grounded

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 20–27, 2022.
https://doi.org/10.1007/978-3-030-85540-6_3

in the concept of integration and segmentation found in boundary theory. We specify the essential concepts such as persons, domains, availability, interruptions, and notifications. Figure depicts a scenario where the focal user is working in domain A and is being contacted by another user from the domain B. In such a situation it is essential to have a clear model for clarifying if and how the system should notify the focal user (Fig. 1).

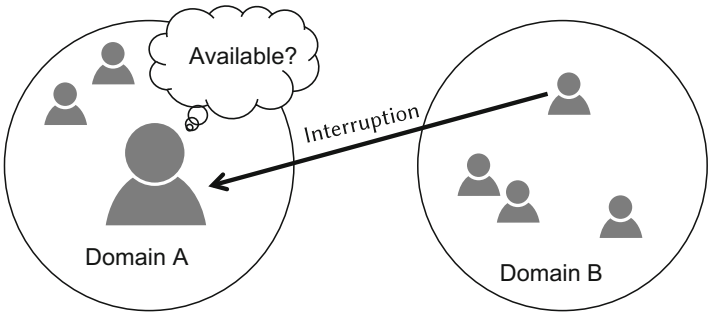


Fig. 1. Scenario of a cross-domain interruption.

This formal model is based on simple set theory and relations. It is system unrelated but serves as a starting point for creating further implementation specific models in UML or other notations during the development process. Formal models accurately specify what we are talking about and set up rules on how one is allowed to reason in the scope of the concept [8]. The advantage of using a formal method especially in such an early phase of designing an application is to add precision, to help understanding and to reason about properties of the design [17].

2 Theoretical Framework

Modern information and communication technology and approaches such as bring-your-own-device (BYOD) bring a lot of flexibility but also lead to a huge amount of interruptions from different life domains on the same device. Yet availability for different domains varies. Boundary management helps to control which interruptions may cross borders according to the person's receptivity for interruptions of each domain. The availability for cross-domain interruptions refers to the degree to which an individual is more integrating or segmenting two domains [10]. Segmentation means an inflexible and impermeable mental as well as physical boundary [6] and no conceptual overlap between domains exists [10]. Creating such strong boundaries enables users to concentrate on the current domain and less on others [1].

To define the availability for an interruption, it is necessary to specify to which domain the interrupting person refers. The assignment of an individual's contacts to exactly one domain is clear for extreme segmenters. The contact information of persons allocated to more than one domain, if they exist at all, is separated according to the domain (e.g., by using different address books [14] or having several numbers or contact entries stored on mobile devices). The less a person segments his or her domains, the

harder is an unambiguous assignment of interruptions to a single domain. The communication channel used can give an additional hint, as in different domains diverse channels are common (e.g., email in work, messengers in non-work) [11]. Figure 2 shows an exemplary assignment of contacts to domains for a more integrating person.

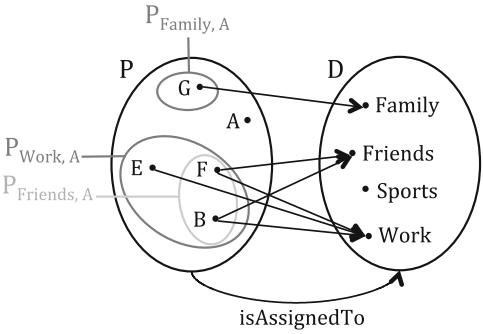


Fig. 2. Exemplary assignment of persons to domains for an integrating individual at a fixed time t. A to F are initials of names.

Following this distinction of integration and segmentation, availability for interruptions is different depending on the behaviour of the receiver in the current domain (i.e., is he/she more integrating or segmenting) and the domain of the sender. For highly segmenting persons, availability is high for within-domain interruptions, but low for cross-domain interruptions. Those who show an extremely integrating behaviour are equally available no matter which domain the sender is from. We are mainly interested in persons who are neither totally integrating nor totally segmenting. They have the greatest demand for managing interruptions across boundaries as they are less strict than segmenters but not as flexible as integrators.

Moreover, the availability also depends on the currently present persons and the domains they belong to. As the behaviour of an individual varies in different roles, the receptivity for interruptions of specific domains also changes [10]. Hence, we also include this factor in our model of interruptibility.

Another aspect that is relevant for our model is that boundaries between domains are not static. Boundaries are continuously redrawn, opened and negated [2], which means objects and persons can move from one domain to another and back again within time. The impact on our model shows in an additional time factor.

3 Approach

As this theoretical description of relationships and dependencies in natural language is hard to translate into a system, we create a formal model summing up all findings necessary for a theory of interruptibility concerning different domains.

In Human-Computer Interaction formal models focus on different aspects of reality: the problem domain, the interaction, or the system. Those models differ in the level of abstraction concerning the resulting system. An abstract formal model explains the

problem without referring to the developed system at all (e.g., DSML [9, 16]). A concrete model specifies the structure of the system (e.g., using Z or UML [3, 17]). In between, formal models describe the user interaction without implementation details (e.g., using PiE or TAG [5, 15]). Figure 3 shows the classification of formal methods according to the subject in reality they describe and their abstractness and concreteness respectively.

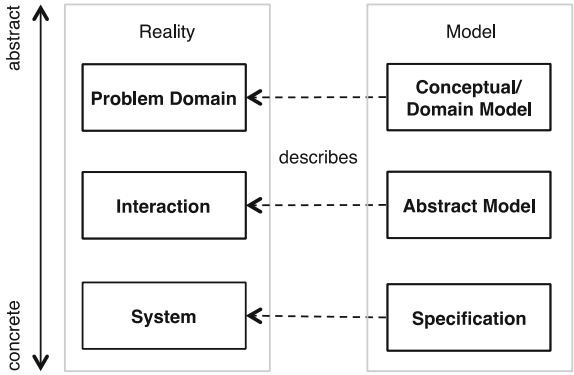


Fig. 3. Different models and the corresponding subject they describe.

In our conceptual model we describe the mental structure of humans concerning a specific domain. We completely separate this step from later interaction and application development. The advantage is, that the model is independent and can be used in different systems, no matter how they are implemented or which architectures they use. What we are modelling is a problem domain that is not physically tangible and cannot be observed from outside. It describes a mental concept.

As we want to formally describe our understanding of a specific concept in real world instead of notating the functionality of a system in the first step, we do not use an implementation-related notation. Instead we decided to use simple set theory, basics of first-order logic and n-ary relations. Set theory allows explaining the possible assignment of instances to a set, constraints and particularities of this assignment and relations between the instances of objects in a few simple and short formulas. The advantage of this approach is, that we have a clear definition of our assumptions about the user's mental concepts concerning her life domains.

Person. P is the set of all persons in the world. P cannot be empty ($P \neq \varnothing$). Persons have a name and several types of contact information (e.g., email addresses, phone numbers). Other attributes of humans are disregarded in our model.

$$P \subseteq Name \times \mathfrak{P}(ContactInformation)$$

Domain. D is the set of all domains. D cannot be empty ($D \neq \varnothing$). A domain consists of the role a person has in the domain, the specific behaviours and rules imposed by the domain, its objects, the physical borders given by locations and times, its channels used for communication and a validity timestamp as domains can also change over time. The

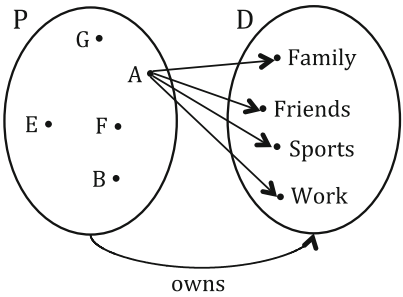


Fig. 4. Example for applying the relation *owns* to a set of persons and domains.

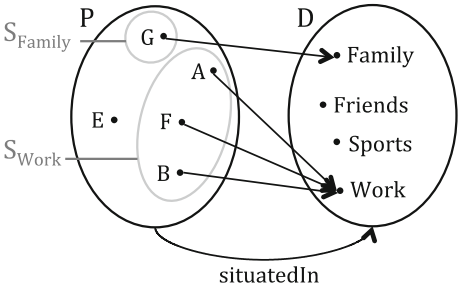


Fig. 5. Example for applying the relation ***situatedIn*** to a set of persons and domains at a fixed time t and building subsets.

relation *owns* specifies which person possesses the domain (i.e., the focal person, see example in Fig. 4).

$$Time : T = \mathbb{N}$$

$$D \subseteq Role \times \mathfrak{P}(Behaviour) \times \mathfrak{P}(Rule) \times \mathfrak{P}(Object) \times \mathfrak{P}(Location) \times \mathfrak{P}(Time) \times \mathfrak{P}(Channel) \times T$$

$$owns \subseteq P \times D$$

Assigned Persons. The relation *isAssignedTo* shows the focal person's assignment of other persons to associated domains. The set $P_{d,p,t}$ is defined as the subset of P containing all persons that are assigned to one domain d belonging to focal person p at time t. Figure 2 is an example on how a graph accompanies our model containing the defined subsets.

$$isAssignedTo \subseteq P \times T \times D$$

$$P_{d,p,t} \subseteq P$$

$$P_{d,p,t} := \{q \in P : owns(p, d) \wedge isAssignedTo(q, t, d)\}$$

Current Situation. The relation *situatedIn* maps a person to the domain in which he/she is currently present. $S_{d,t}$ is defined as the subset of persons that are located in the same domain d at time t (see example in Fig. 5).

$$situatedIn \subseteq P \times T \times D$$

$$S_{d,t} \subseteq P$$

$$S_{d,t} := \{p \in P : situatedIn(p, t, d)\}$$

Availability. Relation A describes the availability of the focal person for different interruptions. Availability depends on the focal person it belongs to, the domain of the interruption, the currently active domain where the focal person is located in, the time, the persons situated in the currently active domain (i.e., availability is different if the individual is alone, in the domain together with only domain members or also together with domain foreigners) and the communication channel of the interruption.

$$Availability : A \subseteq P \times D \times D \times T \times \mathfrak{P}(P) \times Channel$$

Interruption. Interruptions relate to the person that is interrupting, the person that is interrupted, the time of occurrence, the communication channel used for interrupting and the content of the interruption.

$$Interruption : I \subseteq P \times P \times T \times Channel \times Content$$

Interruption Domain. The relation *refersTo* maps interruptions to domains. For each interruption from one person to another there exists a unique domain the interruption refers to, which can be determined using the person, the channel and the content of the interruption.

$$refersTo \subseteq I \times D$$

$$\forall i \forall p \forall t (i \in I \wedge p \in P \wedge t \in T \wedge \exists! d$$
$$(d \in D \wedge isAssignedTo(p, t, d) \wedge refersTo(i, d)))$$

Notification. According to the availability for a certain domain, the notification of an interruption can differ. The attributes of notifications are the presentation modality (e.g., visual, auditory), the concrete layout of a notification (e.g., type of sound), and the timing (e.g., immediately or differed to a later point in time).

$$Notification : N \subseteq \mathfrak{P}(Modality) \times Layout \times Timing$$

Those are the entities we defined in our model. If an interruption appears, we can conclude the focal person's current availability for this interruption and an appropriate notification can be chosen to present to the focal person.

4 Application of the Model

The presented model is formal and concise as it only uses a few formulas to describe all relationships. Departing from it, a system-related notation can be used to specify the implementation of the modelled entities. As an example, we created a UML class diagram containing the sets and relations of our model as classes and relationships shown in Fig. 6 (left side). Figure 6 (right side) presents an object diagram covering the exemplary assignment of persons to domains of Fig. 2. Overall, it is possible to represent the structure and behaviour of our formal model in other representations such as UML. However, diverse structural and behavioural UML models would be needed.

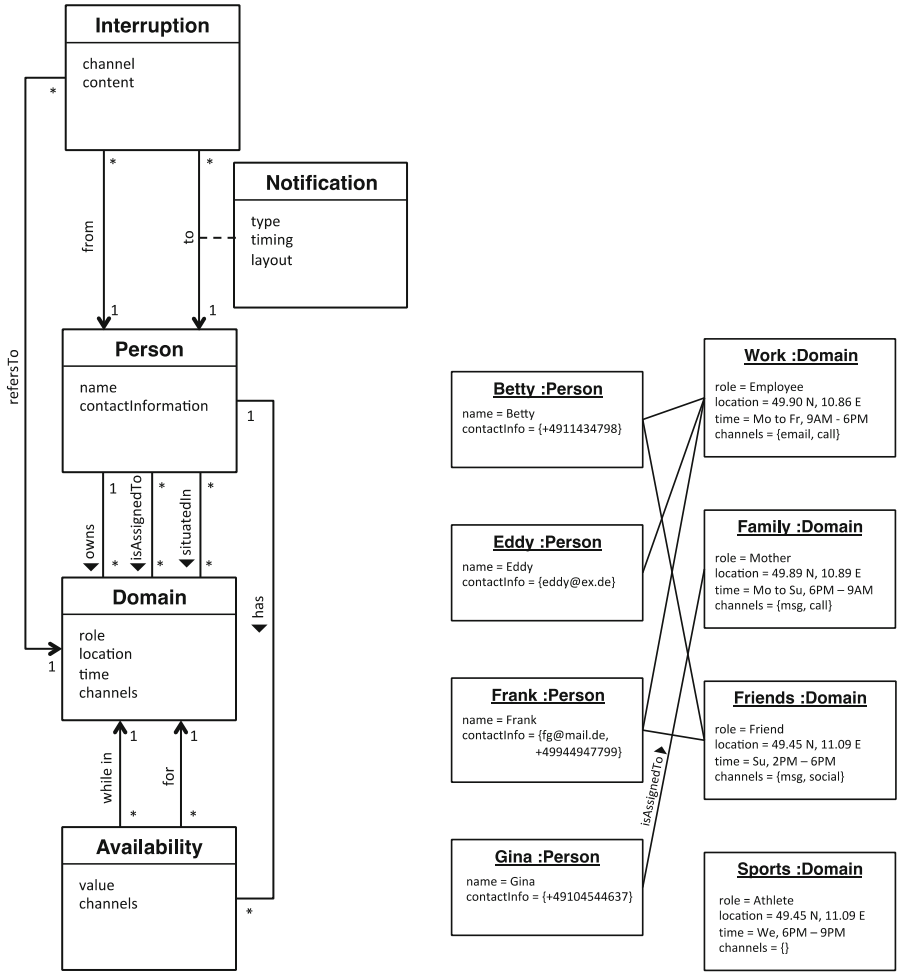


Fig. 6. UML class diagram of interruptibility (left side); UML object diagram containing the assignment of persons to domains (right side);

5 Conclusions

In this paper we have presented a formal model that serves as a basis and as an input to developers of future cooperative systems that aim to allow users to model different life domains (such as a work domain, and a family domain) and to minimise interruptions between them.

Acknowledgments. We would like to thank members of the Cooperative Media Lab.

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Progressive Intensity of Human-Technology Teaming

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Abstract. Human-technology combination is normally conceptualized on a bipolar dimension from no technical autonomy to full technical autonomy, and consequently from full human control to no human control. This paper presents an alternative scale for describing levels of human-technology teaming. It assumes complementarity of humans and technology. Humans and technology are considered to remain qualitatively different in spite of new technical capabilities. When combined smartly, they are able to mutually compensate for weaknesses and to mutually reinforce strengths. On the proposed scale, both full human control as well as full technical autonomy are on the lowest level, as there is no teaming at all. Higher levels represent an increasing intensity of teaming ranging from (i) technology informs the human, via (ii) human and technology influence each other to (iii) true human-technology collaboration that allows for shared control. These levels are described and substantiated in the paper.

Keywords: Human-technology teaming · Complementary system design

1 Introduction

Due to an exponentially growing increase in hardware performance, qualitative new technical capabilities have emerged [1]. This is because the performance enhancement makes it possible for technology to process a huge amount of data in a self-learning manner. With this - and this is a very important qualitative leap - the problem referred to as Polanyi's paradox can be overcome [2]. Polanyi's paradox states that people know more than they can say. What people can express is their explicable knowledge but not their tacit knowledge. Since in conventional automation technology has to be programmed by humans using rules (or algorithms), the non-explicable tacit knowledge is a barrier to what can be automated. As a consequence, the emerging technical ability to learn by itself, allows to automate tasks that were not automatable before. In terms of a qualitative leap, two new technical capabilities result: Pattern recognition and autonomy.

Pattern Recognition. Pattern recognition through machine learning is a substantial advantage with regard to decision support systems [1]. Conventional expert systems (e.g. the general problem solver) were based on programmed rules. On the one hand, however,

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 28–36, 2022.
https://doi.org/10.1007/978-3-030-85540-6_4

they turned out to be very error-prone and, on the other hand, their generalizability, i.e. their applicability to other situations, is very limited. The reason for this is that the human experts who provide the rules for conventional expert systems possess a great deal of tacit knowledge that is not transferred into explicit rules. In contrast, data-based pattern-recognition by machine learning allows for decision support systems that recognize rules themselves and hence are independent from explicable human knowledge. However, a new problem arises out of this capability, which is a kind of a reversed Polanyi's paradox: By self-learning, the technology for its part builds knowledge, which it can no longer communicate to humans (cf. below: explainable artificial intelligence).

Autonomy. Machine learning is also a key technology for autonomous systems. A system is autonomous if it can achieve a given goal independently and adapted to its situation without human intervention and without detailed programming for a situation [3]. Such systems are capable of mastering complex data processing and automatic object identification right up to the creation of a digital representation of reality that is sufficiently accurate for successfully pursuing objectives in dynamic contexts [2]. This enables self-driving cars, for example. The benefit is not just in the automation. Rather, autonomous systems may also be resource-saving. If cars drive autonomously, i.e. if they are not dependent on a person driving them, it makes no sense to leave them standing around in parking lots waiting for human drivers. The use of mobility services will then be more economical than owning a car, which will reduce the number of vehicles required [3].

Human-Technology Relation. With pattern recognition and autonomy as two new technical capabilities, the relation between humans and machines changes. For decades Fitt's maba-maba ("men-are-better-at", "machines-are-better-at") lists [4] validly described qualitative differences of humans and machines. As a main difference the human's ability to cope with ill-defined problems in contrast to the machine's superiority in handling well-defined problems was emphasized. On the basis of this difference, concepts for human-machine function allocation were developed that considered humans and machines as complementary (e.g. [5]). The main assumption of complementarity was that humans and machines have different strengths and weaknesses and may - if smartly combined - foster each others' strengths and compensate for each others' weaknesses [6]. With the capability of pattern recognition and autonomy technology has become able to handle ill-defined problems as well. As a consequence, the assumption of human machine complementarity is questioned.

This paper reflects on this question. It takes the position that despite powerful technical capabilities to handle ill-defined problems, humans and machines are still qualitatively different and complementary. Furthermore, it questions approaches that conceptualize levels of technical autonomy and suggests that rather levels of progressive intensity of human-technology teaming need to be elaborated.

2 Limits of Human-Technology Bi-polarity Thinking

It is very common to operationalize levels of human-machine interaction as levels of increasing automation. Sheridan [7] presented a scale with manual process control (The computer offers no assistance: The human does it all" (p. 207)) on the one side of the dimension and full automation ("The computer selects, acts, and ignores the human" (p. 207)) on the other side. Today, corresponding concepts specify levels of technical autonomy ranging from no autonomy to full autonomy (e.g. [8]). Concepts like these are bi-polar with human control decreasing continually from full control to no control. From a human factors perspective there are at least two major challenges associated with it.

First, levels of technical semi-autonomy may create unaccomplishable tasks for humans. The main problem is that humans need to monitor technical performance [9], which at least causes problems like monotony and fatigue. Even worse, humans may lack capabilities when required to supervise a technology that was designed to act quicker and take more factors into account than humans are able to (Bainbridge's Ironies of Automation [10]). Other negative effects of automation on humans are described elsewhere (e.g. [11, 12]). These include for example over-confidence and under-confidence in technology as well as misjudgment of process states, inadequate situation awareness, demotivation or loss of skills and experiences as a result of automation.

Second, it is fundamentally questioned whether full technical autonomy is possible at all [13–15]. Main arguments are twofold: (i) autonomy is not a property of a technology but rather a capability emerging in concrete situations by the interaction of technology, task and specific circumstances. Hence, the same technology may act autonomously in certain situations and fail in others. (ii) In the real world there are no isolated tasks. Rather, all activities need to be coordinated with those of other actors, be this technical devices or humans. Hence, autonomy, i.e. the ability to perform a task alone, but lacking the ability to coordinate with others, is not enough. Therefore, Bradshaw et al. conclude that rather than working on increased technical autonomy, solutions regarding human-technology teaming need to be elaborated [14].

The following section reflects on human-machine complementarity considering new technical capabilities as described above (i.e. pattern recognition and autonomy allowing the machine to handle ill-defined problems independent from humans) in order to better understand what human-technology teaming might look like.

3 Humans and Technology Still Complementary

Although machine learning and autonomy allows technologies to invade the human domain of coping with ill-defined problems, the emerging technical capabilities still are bounded. Some of these restrictions may be due to current technical immaturity and hence may improve in future. However, others are more fundamental, reflecting cardinal differences between humans and machines.

Mitchell describes shortcomings of machine learning algorithms [1]. For neuronal network based learning, these are mainly biases in decision models the algorithm learns from biased training data or by overfitting to training data sets. Furthermore, decision

models are impenetrable for humans and hence create a "dark secret". For reinforcement learning algorithms she mainly questions the ecological validity of the algorithm's learnings. This because such learning normally does not happen in real world settings but in simulations. Furthermore, in complex real-world settings it is not always clear what a success is and accordingly what actually should be reinforced.

Technical autonomy as well shows numerous shortcomings. Russel for example points to the fact, that autonomous systems aim at achieving a programmed objective without embedding corresponding actions into a greater value system [16]. Chen argues that such embedding is not computable, since compliance to legislation and ethics is always based on social negotiation processes that are and need to be impugnable [17]. Other authors question whether technical systems are able to take decisions at all since decision-making always requires sense-making [1, 13, 18].

Of course, humans are not perfect either. "To err is human" as already was known in the ancient world. However, it seems that a cardinal difference between humans and machines is human understanding and sense-making. This requires common sense, background knowledge, theories of mind, and the like (e.g. [1]). For clinical decision support systems (CDS) for example, technically generated decision suggestion usually require an interpretation that takes the context into account [19]. Thereby not only contextual knowledge of human experts needs to be integrated into decision-making, but also, for example, the needs of the patients concerned. Already Floridi has pointed out that machines can calculate much better than humans. Humans, on the other hand, can think [20]. Calculating and thinking are not the same, however.

It can be concluded that humans and machines despite new technical capabilities as described above, are still qualitatively different and complementary. Based on this assumption, the following section conceptualizes different intensity levels regarding human-technology teaming.

4 Progressive Intensity of Human-Technology Teaming

The scale of different human-technology teaming levels presented here, reflects the qualitative differences of humans and machines as just described. Hence, it is based on the assumption that humans and machines show qualitative different strengths and weaknesses. Furthermore, it adapts a complementary design approach [6] and thus aims for a human-technology combination allowing for mutual compensation of weaknesses as well as for mutual reinforcement of strengths.

Consequently, the proposed scale does not range from human control to full automation or from no technical autonomy to full technical autonomy. Scales like these conceptualize a bi-polarity between humans and machines, which are rather competing regarding control than collaborating. In contrast, for describing human-machine teaming we suggest a scale with levels of an increasingly intense human-machine collaboration. A scale like that is rather orthogonal to bi-polar conceptualizations of increasing technical autonomy.

Basically, it encompasses two aspects. On the one hand, with regard to the relation of humans and machines, a distinction is made between "automate" and "informate" [21]. While the former aims at replacing humans by technology, the latter aims at complementing humans with technology. On the other hand, mutual complementation of

humans and technology can be increasingly integrated. These two aspects result in the following levels of increasing collaboration intensity in human-machine teaming (cf. [22]):

- Level 0: Automate: Technology works independently from humans.
- Level 1: Informate: Technology supports people in making better decisions by providing information for better decisions.
- Level 2: Interact: People and technology influence each other, for example by learning from each other.
- Level 3: Collaborate: People and technology work together synergistically by coordinating each other and making decisions together.

Following, these levels are outlined in more detail.

Level 0: Automate. Since automation aims at replacing human skills and human effort by technology [21], there is no human machine interaction required - at least in theory. In practice, however, no technology is fully independent from humans (yet). If there are no humans required on the operational level, then at least on the levels of maintenance or engineering [23]. Hence, automation is level 0 on our scale since human-machine teaming is not really envisioned. Human factors related problems arising from this level have been mentioned above.

Level 1: Informate. On this level, people set goals and are supported by technology in achieving them. Consequently, technology is applied to increase human performance, which is also known as augmented intelligence or augmented cognition [24, 25]. With the support of technology, humans should be able to make more precise decisions [26] or be supported with regard to their susceptibility to errors [27]. Prerequisite for augmenting the humans' cognitive performance is that people can understand and interpret technically generated suggestions. Consequently, the need for explainable artificial intelligence (XAI) is postulated [28]. However, final decision-making and hence taking of responsibility is with the human.

Kirste points out that interaction of humans and technology requires that technology is accepted by humans [25]. The prerequisite for this is confidence in technology. However, confidence should not be a blind one, but rather develops through understanding and explainability. When people, as a result of overconfidence, accept suggestions from decision support systems without checking them or looking for additional information automation complacency results [11]. It is therefore recommended to avoid features in the design of technology that makes it appear more competent or more convincing, as this could lead to overconfidence [29].

Level 2: Interact. This level includes level 1. In addition, technology not only provides humans with understandable information, but humans and technology actively influence each other, e.g. by mutual learning [28]. Kirste describes specific ways of mutual learning [25]. He differentiates between (a) interactive learning, in which people can influence the machine learning's model formation before or after the learning phase, (b) visual analytics, in which large amounts of data are visualized using methods of machine learning in such a way that people can gain knowledge, and (c) dimension reduction,

in which humans reduce the parameters that the technology has identified in a self-learning manner. Also, Schmid and Finzel describe a form of interactive, mutual learning by combining sub-symbolic black box methods of machine learning with symbolic white box methods that are understandable to humans [30]. This allows the humans to continually influence the technology.

On the other hand, technology can explicitly influence humans and hence support human learning if it communicates proactively with people. It may for example provide humans with information even if they are not (yet) looking for it [31]. This may also mean that the machines need to be able to understand the humans' intentions and needs [32, 33].

Level 3: Collaborate. This level represents full human technology-teaming. Based on their complementary differences, humans and machines work together in a synergetic way in order to achieve common objectives. Doing so, they coordinate their activities and take decisions together. Both are (still) utopian. Regarding mutual coordination of activities, on the one hand Bradshaw et al. assume that technology is not (yet) able to coordinate its actions with humans [14]. However, recent insights in human-robot interaction may contribute to further development (e.g. [34]).

Joint decision-making on the other hand requires joint responsibility-taking. Corresponding concepts are still to be developed. Chen suggests a concept with checks and balances on different decision-making levels. Thereby he differentiates between frontend and backend processes [17]. At the frontend there are functions of execution, where speed and accuracy are important (e.g. a self-driving car taking an emergency break). This is why the machines should be in the lead here. However, the machine acts according to rules defined by the human in backend processes, which encompass legal, ethical, and regulatory functions. Schmidt and Herrmann suggest an "intervention user interface" that allows the human to intervene into the autonomous processes at any time [35]. These interventions allow the human to change the predefined course of a process and have the following three characteristics: (a) interventions are unplanned and occur exceptionally, (b) interventions can be initialized quickly and have an immediate effect, and (c) interventions have a feedback function and help to improve the autonomous behavior of the technical system.

However, despite progress regarding mutual coordination and joint decision-making, the problem of human-machine collaboration on level 3 is not (yet) fully solved. Especially regarding decisions that need to be taken quickly at the frontend, humans and machines rather are taking partial decisions separately. Consequently, there is a partial loss of control for humans. According to Grote, systems should be designed in such a way that such loss is kept as small as possible and made transparent to the human [23]. Waefler suggests that human loss of control might be compensated by social resilience. However, corresponding sociotechnical system design concepts are still to be developed [22].

5 Conclusion

This paper starts with a description of new technical capabilities, which mainly are pattern recognition in complex data sets and autonomy. It argues that these capabilities

allow technology to take over activities that hitherto belonged to the human domain. More specifically, this refers mainly to the human capability to cope with ill-defined problems. As technology invades this human capability, the question is how to best combine humans and technology. Corresponding conceptualizations suggest a bi-polar dimension of increasing technical autonomy and hence of decreasing human control. Such, humans and machines are considered competitors rather than team players. As a consequence, this approach is not really suitable for conceptualizing human-technology teaming.

Instead, we suggest to take an orthogonal approach to better understand true human-technology teaming. Rather than competing for control, humans and machines are envisioned to progressively intensify collaboration. This is based on the assumption that humans and technology remain complementary although technology shows new capabilities that used to be exclusively part of the human domain. Significant remaining differences of humans and machine are for example sense-making, understanding but also negotiating where there are no clear solutions.

We suggest three levels of progressive intensity in human-technology teaming: (1) informate, (2) interact, and (3) collaborate. On levels 1 and 2 promising results can be found in literature (e.g. XAI or mutual learning). However, level 3 - i.e. on the level of most intensive human-technology teaming - still requires research especially regarding possibilities to compensate for loss of human control.

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Cultural Difference of Simplified Facial Expressions for Humanoids

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Abstract. In this study, we found effective facial expressions with the minimal elements required to identify someone's emotion. One circle for each eye and one for the mouth makes triangular facial expressions. In all the preceding studies, facial expressions have only used visual details that had been shown in three dimensions, with the mouth being stretched wide, the face tilted, and the eyes slanted. As well as previously discovered in affective studies, the correlations between visual input and outcomes have correlated. We discovered that people exhibit ten expressions of feeling, which are (I) happy, (II) angry, (III) sad, (IV) disgust, (V) fear, (VI) surprised, (VII) angry*, (VIII) fear*, (IX) neutral pleasant (positive), and (X) neutral unpleasant (negative). Mathematical transformations transmitted the feelings. Cultural variations are also noted in face expressions described in the article.

Keywords: Human factors · Human-systems integration · Design

1 Introduction

As human beings use facial gestures to communicate their feelings, their faces are of supreme significance, and their faces are almost important in expressing their own. Emotions are conveyed in many different ways in various sections of the face: the eyes, the mouth, and the nose may change in conjunction with it. Speech is the process we use to get our needs fulfilled. Many primates, including humans, use the eyes to define a face. Additionally, people have shown a distinct preference for graphic designs of faces (a face at the peak of an upside-down triangle) in recognition studies. This study findings indicate that primates look at faces as patterns of items made up of distinct facial features, especially the eyes and the mouth. [1, 2, 4, 5, 9, 10, 15, 16].

In contemporary times, there are two competing views about facial expressions: The first assumes that all expressions should be placed in a subclass, while the latter asserts that people have dimensions that express all categories. The human race judges the significance of facial expressions by way of meaning which is more or less familiar to all people. The proof to support this hypothesis emerges from research of both psychology and evolution. This hypothesis is often countered by others that state that facial

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 37–43, 2022.
https://doi.org/10.1007/978-3-030-85540-6_5

expression is constant, not distinct, throughout the psychological phase. According to Ekman and other investigators, six feelings -- happy, angry, sad, disgust, fear, surprised -- are more common. It is believed that there is a strong one-to-to-one correspondence between specific feelings and physiological ones, bodily reactions, and it is suggested that no facial expression can be perceived apart from this connection. [3, 11, 14, 15].

The term category theory implies that emotional judgement is focused on two or three-dimensional space, and that the expression takes place following that space. Many who embrace this theory of human diversity will argue that the unique factor among all people is not categories but dimensions. We start with Schlossberg's theory of emotions, such as that which includes two components, comfortable vs. uncomfortable and focus, in addition to stress. After this study, other researchers have discovered affective aspects and have used the pleasantness versus unactivity and attentiveness versus apathy elements in their discussions (aware vs. asleep). Recently, the circumplex model, introduced by Russell, has proved to be true across all cultures and topics. [6–8, 11, 12, 14].

As such, after Schlosberg's study, a whole lot of various hypotheses regarding the affective (psychological) part of face recognition have arisen. However, there have been several studies on the ability to understand gestures using photographs as the main source of visual knowledge. These researchers are trying to create a link between emotional speech and human cognizance that has not yet been made.

To further investigate the correlation between facial expressions and visual detail, Yamada used an eight-part visual analysis in which the eyebrows, pupils, as well as other facial features, were simplified. For the results, two physical variables have been identified: inclination, which means the slope of the curves, and positioning, and indications, which mean transparency. They say that accessible personalities are more likely to be more polite and slanted, as well as extroverted. Using this understanding, they indicated that three mechanisms are at work: recognition of visual knowledge (one is physical), emotional recognition (which uses influence the emotions), and comprehension of the face's sense. [13, 14].

It has also been noted from the studies utilizing real human faces that there are three visual variables—slantedness, opening of the mouth, and eyes—that they influence three-dimensional structure. In addition, it's also established that the association between slantedness of the mouth and pleasantness and the varied expressions of interest; as well as the relationship between slantedness of the eyes and activity levels of interest exists. Based on the findings of real and competing faces, it was observed that there is a clear correlation between transparency of the eyes and pleasantness. When we think about physical or emotional details, there is a clear correlation with vision (the affective variable).

2 Facial Gestures with the Fewest Numbers

Our goal in this article is to verify the previously discovered physical relationship, as well as extend what we already know regarding humanoid facial design to robots. Without clarification, little progress can be made in cognitive studies on facial expression. For this post, we have used the fewest possible geometric elements to allow recognition of the face patterns. The book deals with both physical and geometric transition The

facial expressions in this grouping are synonymous with each specific emotion, and are defined by the use of principal component analysis on physical and affective evidence. The conclusions of our study ultimately resulted in a paradigm that enables us to convey emotions on the face.

However, we studied the neutral face, which has seldom been stated in the previous scientific literature. Work done in the last decade or so suggests that the neutral face would not reflect neutrality, but instead feeling that is related to the facts of life.

When utilizing geometrical images instead of realistic, the connection between facial components and variables is rendered explicit. Because of this partnership, we are working to repair not only facial architecture, but also neurological deterioration of facial expression with robots. Thus, the findings of this study can be extended to other disciplines.

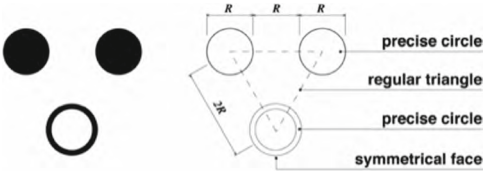


Fig. 1. Left: Basic face before transformation; Right: Transformation of eyes by each parameter.

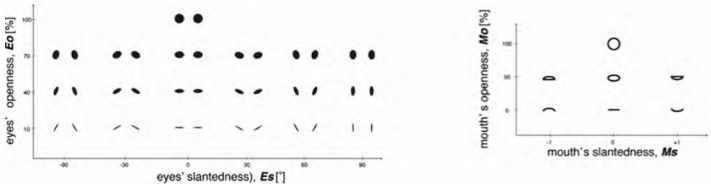


Fig. 2. Left: Transformation of eyes by each parameter; Right: Transformation of mouth by each parameter

2.1 The Style

Elements that have only two, the eyes and the inverted triangle, situated on the forehead are reduced to three: the first one circle on the top and one circle on the bottom (Fig. 1). Facial expression variations are generated by applying a transformation to the parameter "slantedness" plus one of the "openness", which often influences cognition. Coving of the eyes is a parameter that shows the deformation according to the rotational movement of the eyelids, thus slantedness of the mouth displays deformation by the change in the height or rounding of the corners of the lips. The vertical transformation of the exact circle coincides with the rise in transparency. In Figs. 2 and 3, the eyes and the respective pupils shift size according to the values plotted on the x-axis and the y-axis. Using the graphical patterns seen in Fig. 2, the eyes will create 133 patterns, while the mouth can produce 7 unique expressions, for a total of 163. It is generally thought that the facial expression is directed at the viewer, and faces are symmetrical.

Each facial expression has four parameters: two facial expression parameters: one parameter of the eyes, and two for the mouth: slantedness and openness. So, the face coordinates can be expressed as the following: $f_i = (Es_i, Eo_i, Ms_i, Mo_i)^{\mathrm{T}}$.

The above mathematical expression shows the coordinates of the *i*-th facial expression, where *Es* and *Eo* represent the eyes' slantedness and openness respectively, and *Ms* and *Mo* represent the mouth's slantedness and openness respectively. By principal component analysis we would be able to reduce dimensions of the space that f_i spans and get $f'_i \sim f_i$ where $\dim f' < \dim f$.

2.2 Patterns of Facial Expression Classification

Patterns of facial expressions are obtained and assigned to a primary emotional class. Six basic emotions, including rage, are listed by Ekman and others. The theory often shows no feeling yet provides a friendly gesture of the way in order to assess neutral facial expressions. Particularly for robots without facial expression, the clear face is necessary.

A great deal of knowledge and experience is needed to classify facial expressions. These are the three basic principles for a task: To response, we must choose one emotion (or no emotion); we don't have to choose one category for one face; the category can be used with more than one face.

2.3 Facial Expression Patterns Distributed in Mathematical Space

Every expression is given four-dimensional coordinates as stated in Sect. 2.1. Classified expressions are distributed according to these coordinates, we describes a facial pattern in four-dimensional space. Response blocks occupy more than two-quarters of the screen and about two-thirds of the face pattern distribution is missing.

If the speech space has been developed, the proportions are trimmed down to provide a clear, visual representation for the human eye. In this case, using facial recognition and simulation, we will see spatial patterns and their parametric values.

3 A Result of Classification and Spatial Distribution of Facial Expressions

In the effects of the PCA, three distinct variables emerged: the appearance of a grin on the lips, the angle of the eyes, and the presence of an open eyes. Furthermore, these distributions often align with expressions that were used in other experiments on emotions in general, which contribute to our observations of the specific results for faces.

In addition, the past study is being consolidated with 10 simple facial expressions: happy, angry, angry*, sad, disgust, terror, fear*, shocked, neutral (pleasant), and neutral (unpleasant) (Fig. 3).

3.1 Face Distribution in a Three-Dimensional Space

The detection of facial feature search was granted to 140 individuals of various ages between the ages of 14 and over 60. (average age in their 20s). This table shows the

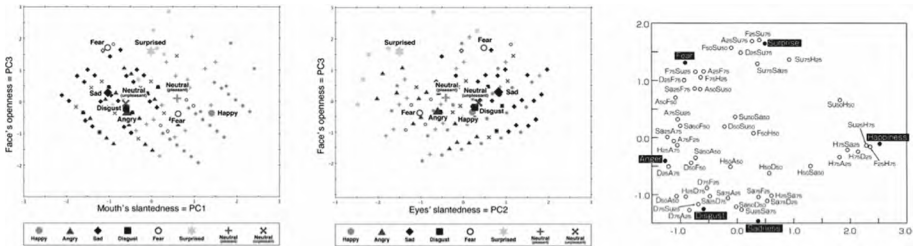


Fig. 3. Left: Projection plane of three-dimensional space for facial expression composed of slantedness of the mouth and openness of the face; Center: Projection plane of three-dimensional space for facial expressions composed of the slantedness of the eyes and the openness of the face; Right: Circumplex mode constructed by Takehara & Suzuki (2001)

outcomes of the four-dimensional principal component analysis. When four-dimensional space is calculated as the summation of principal components, the effect is 0.807. There are three additional components whose value is tabular values are seen in Table 2: According to this interpretation, principal component-1 would be called slant of the lips, and principal component-2 would be judged to display the slant of the ears, and principal component-3 suggests both the slanted and non-slanted looks. Previous experiments provided three different forms of visual input were correlated to this finding [3, 6].

In order to explain the connection between this study's emotional sense and visual meaning, we used a plane with the activeness of the face that was acquired through previous studies with two other planes, a three-dimensional projection space to equate the two faces. See Fig. 3 Left and Fig. 3 Center. any emotion has a numerical weight compared to how many times it was chosen from among the choices [3, 14].

The distribution of happiness, surprise, anger, and fear can be described as almost identical to the shape of disgust. Additionally, we could distinguish two concentrations of anxiety, as seen in Fig. 3 Right. We arrived at this hypothesis by taking different pictures of individuals, modeling the images into 3D space, and calculating the distances between the various facial expressions.

Anger, sadness and distaste were tested by means of a three-dimensional projection that included a slant of the eyes and an open expression, respectively. From this, because of the width of their pupils, the slant of their heads, each gesture was divided into two dimensions. So we learned that the knowledge gained from gazing at faces is made up of three factors in the context of body language, according to his results (Table 1).

Table 1. Result of principal component analysis

Principal component	PC1	PC2	PC3	PC4
Standard deviation	1.119	1.034	0.951	0.873
Cumulative proportion	0.313	0.581	0.807	1.00

Table 2. Meaning of each principal component

Principal component	PC1	PC2	PC3
Eyes-Slantedness	0.280	−0.773	−0.298
Eyes-Openness	0.557	0.125	0.749
Mouth-Slantedness	0.674	−0.137	−0.160
Mouth-Openness	−0.396	−0.609	0.570

3.2 Two Neutral Facial Expressions and Eight Facial Expressions

Behaviors in addition to the exploration of face distributions, we discovered ten facial expressions: happy, angry, sad, disgust, fear, surprised, angry*, fear*, neutral (pleasant), and neutral (unpleasant). The different facial expressions are seen in Fig. 11. When we are upset, our eyes and mouth appear to be wide open. Fear may be distinguished by the shape of the eyes and the open lips: this is apparent when one's face is rendered in a slant.

4 Discussion and Conclusion

To obtain the visual component, which was defined as the slantedness of the eyes, the general jaw shape, the placement of the mouth, and the size of the visual variable ones were recorded, while the slant of the eyes and how open they were observed. It was discovered by studies and three-dimensional measurements that there is a major connection between the form of the mouth and the measurements of pleasingness and transparency.

Looking at three-dimensional distribution, it may also include valuable knowledge regarding the forms of facial expressions: in particular, rage, depression, and disgust. Thus, the third component aids the understanding of facial emotion, which exhibits a high correlation with judging of feelings of anger and sadness.

Many previous studies have contrasted how people interpret facial gestures using real faces or photos and designs that imitate them to how we, the real face will appear. Conversely, in this paper, the minimal facial features necessary to identify a face were identified, and the face was used only for experimentation. Geometric transformations of the eyes and the mouth were used to create the different facial expressions seen.

On the basis of the experiment findings, it was noticed that even faces with minimal facial features were capable of identifying the emotions in images. Thus, it is possible to identify a human's mood using just two eyes and a vertical and horizontal scaling of the lips to match a person's height.

This research successfully identified the facial expressions with the fewest required visual elements and facilitated human perception of them. The forms used for the minimal face were circles transformed into two eyes and a face with scaling and rotating. Several prior studies had proposed three-visual factors when it came to facial expression: The mouth turned slightly to the side, the eyes were wide, and the facial feature was

non-geometric. Thus, the findings of this study suggest that human beings can categorize gestures to fit that of a human face. Additionally, previous studies found a similar pattern of findings in the partnership between visual affection and affective sense. These relationships were present between pleasantness and the symmetry of the presence of a third affective variable (that is, energy) was, maybe, linked to slantedness of the pupils.

As the researchers learned, people can be grouped into ten facial expressions: pleased, fearful, unhappy, shocked or both, fearful, and indifferent. Geometric transformations and differences in the eyes and the lips were used in their makeup to create these facial expressions. Additionally, the writers found a tetrahedroniral model that rendered facial expressions geometry look more geometric. This model is described by having each expression on one of the vertices. The combination of the two axes influences the rotating and scaling of the pupils, and the longitudinal relationship of the lips.

This work was supported by Grant-in-Aid for Scientific Research on Innovative Areas No. 18H04203 “Construction of the Face-Body Studies in Transcultural Conditions”.

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"I Think It's Quite Subtle, So It Doesn't Disturb Me": Employee Perceptions of Levels, Points and Badges in Corporate Training

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Abstract. This exploratory study examines the white-collar worker perception of the three most common game elements in learning *Level, Points* and *Badges* applied in online training. Through surveys and interviews, the study reveals that the perception of the gamified course design was engaging. The game elements Levels and Badges were considered positive, while Points was viewed as indifferent. The study also detects that respondents in both the surveys and interviews had not noticed parts of the gamification design, making them negative towards the gamified course due to lack of coherence in the design. The authors of the paper suggest that further studies should address multimodal feedback, juiciness, and gamification to disclose which type of feedback is paramount in various gamified situations.

Keywords: Gamification · Corporate training · Game elements · Design · Juiciness · Multimodal feedback · Learning · Learning management system

1 Introduction

Due to the accelerated digitalisation and automation in industrialised and post-industrial countries, labour market skills are changing rapidly. Employees are likely to participate in lifelong learning to pursue various careers and develop competencies necessary in their current workplace [1]. Concurrently, the labour markets median age is rising, prognosticating later retiring, increasing the retraining demand on the existing workforce [2]. One essential solution for the issue is a corporate training, retraining, or upskilling [3]. A transformation from assembly line production to more autonomous work organizations in the production industries has led to a declining amount of low-skill blue-collar jobs in the manufacturing industries. Meanwhile, the numbers of high-skill white-collar occupations have generally been on the rise [3]. These occupations have traditionally demanded a more consistent strategy regarding renewing and updating due to the skills acquired during formal education currently do not keep pace with the rapidly digitalized work life. In 2017, it was estimated that the half-life of white-collar skills was approximately five years. That is, a skill learned five years ago is half as valuable as it was when

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 44–52, 2022.
https://doi.org/10.1007/978-3-030-85540-6_6

it was learned [4]. In the software industry, the half-life of employee skills is considered to be around ten months [5]. This is predicted to go even faster in the upcoming year's making life-long learning not a luxury for the few but a requirement for the many to stay employable in the labour market. The situation has called for more scalable and quicker learning approaches for corporate retraining. One of the approaches is gamification, which is discussed for its uses in building habits through feedback. Gamification is often described as the application of game design elements in a non-game context [6]. The present case study investigates three of the most commonly applied game elements interface design patterns in learning, *Level, Points* and *Badges* [7, 8] when implemented in a gamified employee training course at an international transport company to understand employee perception of the game elements.

2 Related Work

In the field of human resource management (HRM) gamification has been described to offer an opportunity to enhance engagement and collaboration among employees [9], and to aid HR-departments in influencing employees' attitudes, individualizing training programs, offering incentives, and aligning processes with strategy [10]. Despite this, limited studies have been conducted in the field [9].

Qualitative interview studies have showed higher reported motivation, recognition, feedback, relationships building and enjoyment due to a gamified training program [11] as well as a positive attitude toward gamified training [12]. Another case, including comparative interviews, showed that gamification affected participants eagerness to cooperate, created a more enjoyable training experience, and provided a more positive attitude towards the training [13]. Despite the positive attitude expressed by employees, gamification has shown limited effects on performance outcomes. In a lab and field study showed that even though gamification resulted in higher satisfaction it only led to marginally higher learning outcomes [14]. Similarly, that adding narrative game-elements in a case of employee training had led to increased satisfaction but equal or lesser training scores [15]. In a more long term field experiment, however, gamification showed an increased internal motivation in employee training [16]. Also, in an experiment design study with 22 participants regarding gamified AR-training did not find a significant difference in performance and engagement between a gamified and non-gamified condition [17]. The varied results expressed in previous studies is noteworthy Suppose gamification has value in the upcoming *reskilling revolution* [1] then there is a requirement for a more dependable understanding of different game elements perform in corporate training and how adults perceive different them while they undergo training. The following explorative research question investigated: *How do white-collar workers perceive the most common game elements Level, Points and Badges in a corporate training course?*

3 Methods

The investigated case is a self-paced digital corporate training online course on upcoming technology trends in the production industry given in a Learning Management System

(LMS). Gamification was not part of the initial LMS designed but was added by a gamification studio collaborating with the LMS provider. Eighteen respondents participated in the course that lasted for three weeks. The course had a 68% completion rate, which was higher than the transportation company's average employee courses. Structured interviews were conducted with four participants, and a survey was sent out after the course to all participants. A survey was constructed to collect valid information on how the employee *perceives the game elements* in their corporate training. The survey consisted of 14 balanced equally between ordinal- and open-ended questions. Ordinal questions used a seven-point Likert scale addressing questions such as "*My experience of XX in the course was…*". The ordinal questions were followed with an open-ended question asking the respondent to elaborate on the previous question. The purpose of the chosen survey design correlates to the survey objective to gather comprehensive data from the respondents [18].

In the standardized open-ended interview, the participants were asked the same questions in the same order. They were expected to contribute with extensive, open-ended answers regarding their perspectives and experiences, providing a substantial and in-depth narrative of the inquiry [19]. Standardized interviews were chosen to facilitate an inductive content analysis [20] in the investigation, pursuing a deep understanding of how the *employees perceive the game elements.* A purposeful sampling of the interview respondents was made by the corporation to address the departments participating in corporate training (Table 1).

Table 1. Respondents

Name in study	Role in company	Age	Course time	Interview length
Respondent 1	Business development	45	3 h	23 min
Respondent 2	Human relation	41	10 h	31 min
Respondent 3	Business development	55	4 h	25 min
Respondent 4	Human relation	31	8–10 h	24 min

4 The Gamification Design Flow

The corporate training was gamified through an API implemented in the corporation LMS by a gamification studio. The API added a gamified visualisation of the employee progression in the course. Every time a task was completed, the employees gained *Points.* When employees completed all tasks in a course block, they were rewarded *Points.* These *Points* were needed to advance *Levels*, which were designed to show employee progression in the course. The *Badge* element served as the backbone of the gamification design. The *Badge* was outlined on a set of different goals and was visualised by different icons. The *Badge* was designed to engage the employees in completing different course tasks in the LMS system. When a *Badge* was completed, the box related to the task was checked. In the gamification design, there were three types of *Badges:* Milestones:

providing information on the employee progression in the course; Social achieved by completing community task like peer-review course mates assignments; Award attained thru being active in the LMS and thorough in the course like complete all the course quizzes with 100%. The *Badges* outline the gamification designer and the corporate learning manager co-designed to increase the employee's probability of succeeding in the course (Fig. 1).

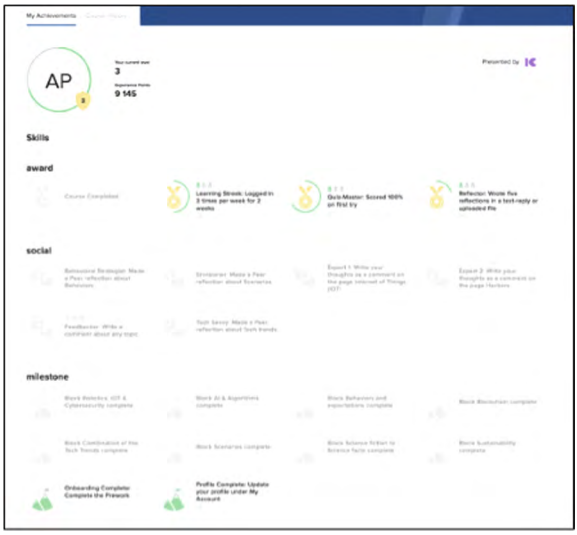


Fig. 1. The gamified dashboard showing the game elements Level, Points and Badge (called Achievement) in the gamification implementation.

5 Results

5.1 Survey Responses

Of the survey respondents 8 out of 9 (88%) were positive toward *Level* 1 skipped the question. 7 out of 9 (77%) were positive toward *Badge*, while the rest were neutral. 5 out of 9 (66%) were positive toward *Points*, while the rest were neutral (Fig. 2).

The employees also gave their remark on the game elements. The employees expressed that the *Level* element provided them with visual progression as the level meter is at the bottom and fills when they were progressing. One expressed concern was how many levels there were in the course. There was also an expression that the employees were not sure of the *Level* element's purpose other than motivation indicating that the respondent was unsure of the *Levels* purpose or expressed an untapped potential.

Employees expressed that the Badge's purpose was vague, expressing a need for clarification. Furthermore, there were opinions that the Badge elements should be better connected with the actual course content. Also, there were comments regarding the

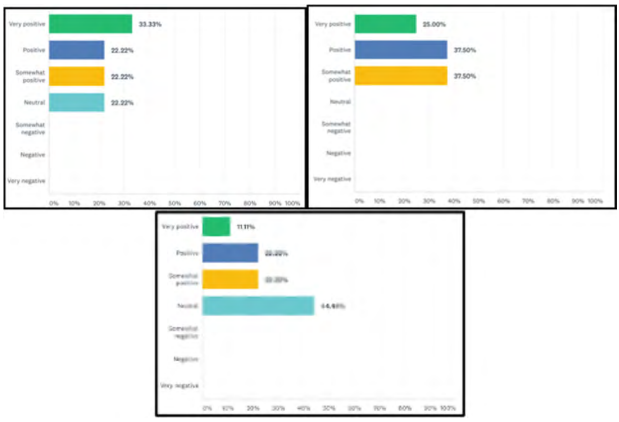


Fig. 2. From left to right descriptive statistics showing perceptions of *Badge*, *Level* and *Points*

Badge element's visibility in the interface, indicating a requirement for a more inductive design approach.

The respondents' opinion about the game mechanic *Points* was that its purpose was vague. The employees displayed that they did not understand the game mechanic significance, e.g. how many points needed for a course' pass or a pass with distinction', etcetera. Also, the employees expressed that *Points* would have a more significant impact on them if an indication of how many points should have been accumulated arriving at a new theme in the course. Again, opinions appeared concerning the *Point's* visibility, as some of the employees had not percept them in the interface.

The game elements *Level* and *Badges* were perceived as more positive than the *Points* in the course, which could depend on the circumstance that Points' intention and purpose were unclear for the employees.

5.2 Interviews

The interviews were done after half of the course was completed. All the interviews were conducted in a timespan of two days. The inductive content analysis addressing the respondents' opinions on gamification and their perception of the game elements gave a diverse representation. In the interview, respondents 2 and 4 expressed being positive toward the gamification set-up, supporting them to stay engaged in the course.

> *"I think it's really good because you have an overview of what you have done so far and what's your level is and so on."* (*Respondent* 4)

Also, there are notions that gamification within this company's corporate training was viewed as something novel and innovative.

> *"From my perspective, it's good that they have done something new and have experimented with this section, taken it to the next step." (Respondent 2)*

Respondent 2 and 4 expressed that gamification gave a suitable outline of the course, making it easy to follow and grasp if they completed the assignments and were in the course they currently were situated. Also stressed that gamification was an appreciated approach in the corporation's learning strategy. However, these expressions were not shared in all the interviews. Respondent 1 and 3 expressed that gamification probably was helpful for some learners but not for themself.

> *"I believe it's a good thing. And I believe that it is the one thing you might need thinking forward […] I don't feel this is a problem […] like it is now. I might not be the kind of person who is buying it (gamification), but it can provide a bit more motivation for some." (Respondent 1)*
>
> *"That might probably motivate some people because we are all different […] I am not personally motivated by it. I think it's quite subtle, so it doesn't disturb me" (Respondent 3)*

Respondent 1 and 3 indicated that integrating gamification in the course was legitimate to aid less motivated course participants underlining the everybody is different, having their drivers and barriers regarding company training. Both respondents also mentioned that the gamification design did not distract them in its current state due to its subtility and nonintrusive design.

However, in the interviews, there was also uncertainty about what was part of the gamification design. Respondent 1–3 had not noticed the *Level* element, and Respondents 1 and 3 had not noticed the *Badge* element. Not recognizing the entire gamification in the interface affected the perception of the design. Respondent 3, who had noticed *Badge*, but not the *Level*, commented on the lack of coherence that some *Badges* were inaccurate due to indicated progress in the course.

> *"Now, when I started to think about it maybe I miss some of it. But I just noticed that you know whenever I submitted an answer (on a course task) I would get a message that I had reached blah blah blah. But you know it wasn't important to me, so I did not pay much attention to it other than remembering it now since you're asking about it." (Respondent 3)*

Respondent 3 noticed parts of the gamification design after two weeks after the course starts indicating that it was due to not considering gamification. In contrast, Respondent 4 had perceived both *Badge* and *Level* and were favourable toward gamification and appreciated the gamification design.

> *"I think there are some good features. The milestone is good because it makes you grasp what's accomplished, what's next and so on. Also, the course completion bar tells me how much that remains of the course." (Respondent 4)*

Respondent 4 had observed the Badge and the Level, and in the interview, she made inferences of how the design flow could be optimised. Respondent 4 suggested that the *Badges* could resemble the course tasks better and that it should be more apparent how much effort it was needed to collect them. This indicated that she had comprehended the gamification design intention and asked the designer to optimise it further. Regarding

Points, respondents 1–3 had not recognised that they were earning points when they completed different course assignments. Respondent 4 had noticed that she was earning points when she finished something in the course but had not comprehended the *Point's* purpose.

6 Discussion

The results concluded that the most common game elements in learning [8] are perceived positive by the employees, especially the *Badge* and the *Level*. *Points*, however, was perceived as less positive by the employees than the *Badge* and the *Level. Points* was perceived as hard to grasp and contained a low significance in the course, which differs from the *Badges* and the *Level*. *Badges* and *Level* were commented as more useful for the employee, giving them a visualisation of their progression. Descending deeper into the notions of the employee's interview, the respondents had a mixed impression on the gamified design. While Respondent 1 and 3 expressed it as a thought-provoking and novel take on the corporate course, they stated that it didn't affect them. Respondent 2 and 4, on the other hand, expressed that the added gamification features in the LMS enhanced the learning experience making the course easy to follow and made it straightforward to track their course progression.

One topic that occurred in both the surveys and the interviews was that some gamification features had been designed too subtle in the LMS interface resulting in that some employees had not noticed them. Not comprehending all the aspects of the gamification designed seemed to harm the perception of gamification. Gamification design has been suggested is not sufficient, just adding game elements [21]. The gameful experience that game elements elicit is what motivates the user [22, 23]. A good gamification design should include *juiciness*, meaning that the user's feedback should apply to several senses in the form of sounds, visuals, and animations [22, 23]. In the investigated case, the *Points*, *Level* or *Badge* may have provided sufficiently informational feedback, but their visual representation was too subtle and lacked "juiciness". A more multimodal feedback approach in the gamified course could have been beneficial.

The inquiry suggests that the current implementation did not offer sufficient gameful and juicy aspects due to gamification's subtle nature, highlighting that visibly-factor should be investigated more and discussed for inclusion in forthcoming studies. As shown here, employees can be positive toward gamification without understanding the purpose of the game elements, highlighting whether a positive attitude toward gamification should be a useful performance indicator. As suggested in previous studies [14, 15], engagement does not necessarily imply increased knowledge; this calls for future research to investigate how game elements in employee training should be designed to elicit more than motivation but also learning performance.

7 Conclusion and Further Research

This exploratory inquiry aimed to exam some of the most used game elements in gamified learning design to determine how white-collar workers perceived them in their

corporate training. *Badges* and *Levels* were perceived as positive by the study respondents, while *Points* was considered indifferent. Both survey and interviews revealed that the game elements had been too subtle, making them hard to grasp for the user indicating a negative perception of the implementation. Therefore, further research should do more investigations regarding game elements localisation in the user interface regarding visibility and understandability for the user.

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Escape Rooms: A Formula for Injecting Interaction in Chemistry Classes

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Abstract. Chemistry teaching requires active methodologies that involve students in carrying out activities that generate critical thinking. The Escape Rooms is a micro gamification strategy where the student escapes from the traditional classroom. In this room the student must find keys, do puzzles, investigate, solve riddles and obtain combinations or objects. The goal of this study focuses on proposing Escape Rooms to strengthen high school chemistry teaching. The proposal contains activities designed by the teacher, which will be solved by students in a certain time using technological resources. To implement this work, a baseline was drawn up through an interview with three teachers from Chemistry area; as well as a 178 student's survey. As a result of the exploratory research, the need for teachers and students to implement playful methodologies is evidenced, this would allow inferring that Escape Rooms is a novel and attractive strategy for teaching chemistry.

Keywords: Escape Rooms · Active methodology · Gamification · Collaborative work · Chemistry teaching

1 Introduction

Chemistry is a theoretical-practical science that contains concepts, abbreviations, formulas, symbols, which can be difficult to understand because it uses a different language [1]. More and more people need to control these concepts due to the implication it has in scientific and social development and that is why it is important within school learning. In this context, chemistry teaching must be related to methodologies that involve students to carry out activities that generate critical thinking, promote motivation and strengthen learning [2]. Taking these aspects into account, it is necessary to incorporate active methodologies, getting this name because they require the student to be involved when acquiring or consolidating skills and knowledge for comprehensive training [3, 4]. The methodology that is currently having a lot of popularity is Gamification, which transfers the elements of games to the educational field, allowing to internalize or reinforce contents in a more dynamic learning climate [5, 6]. One strategy within this methodology is

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 53–60, 2022.
https://doi.org/10.1007/978-3-030-85540-6_7

Escape Rooms, which applies micro gamification, in which the student puts into practice the knowledge of it by solving challenges to escape from a room. It can be designed in a physical or digital environment in order to be the protagonist of their own adventure [7, 8]. In this context, Escape Rooms is a novel and attractive strategy that generates emotion, motivation and critical thinking by solving posed challenges [9].

This research's goal is to design an Escape Room for chemistry subject so that students acquire skills such as teamwork, logical reasoning, creativity, problem solving and the strengthening of skills and abilities related to chemistry course.

For the application of the Escape Rooms, in a first phase the ideas of students and teachers of chemistry area on the implementation of active methodologies have been considered. In the second phase, the game was developed, with a Mario Bros narrative and setting, called Super Escape Rooms, so that students use necessary resources and can solve the challenges posed. 40 high school students participated in this activity, they were organized in work teams in an Educational Institution in Ecuador.

The Escape Room implementation's results in chemistry show the development of student skills such as teamwork, communication and learning motivation. It is an excellent pedagogical strategy because it allows to consolidate the theoretical contents and understand the practical subject's contents.

2 Related Works

Escape Rooms are an educational innovation strategy that allows to carry out participation, organization, monitoring and practice of knowledge activities in an ideal environment for learning process, in this context investigations on proposals made by other authors are detailed.

In a qualitative-quantitative study carried out in the first years of technical careers at Madrid Polytechnic University, an Escape Rooms was applied on the chemical elements Periodic Table. The design contains actions which are developed in three phases: History and location, Enigmas design and Implementation and game tests. The results showed that students acquired basic competencies of the subject through teamwork, as well as knowledge and interest in the history and discovery of the periodic table [10].

In other qualitative research, the Escape Lab was presented as an escape proposal to teach applied chemistry at the secondary level. The Escape Room was designed with eight puzzles involving freshman and sophomore chemistry content. The results show that with the application of this proposal the students assimilated in a better way the contents of chemistry and a greater liking for science [11].

In the same way, a study that implemented an Escape Room in Secondary Education fourth year specifically in Physics and Chemistry subject was found. Its design contemplated the curricular contents related to atomic models, the periodic table, electronic configuration and chemical reactions. The study involved 30 students distributed in work teams to solve the activities in a certain time. The results determined that the Escape Room allows the student to review or assimilate concepts of the subject in a different way, encourage teamwork, increase motivation and interest in the subject and become the protagonist of their learning [12].

In addition to the above, the Escape Room called "ClassRoom Save-thewater" was found, prepared for third-year students of secondary education for the review of Physics and Chemistry subject. The theme addressed environmental awareness and included recreational activities for each of the contents. 120 students participated in this proposal in six sessions through teamwork. The results showed that the activity strengthens students' participation in a collaborative way, the development of attitudes and capacities related to the subject [13].

Finally, Sánchez and Lozano (2020) propose the Escape Room as a didactic strategy for chemistry teaching. The methodology of this study compared the initial and final knowledge that students have about the periodic table and the chemical elements discoveries. The participants in this research were 39 students from the third year of secondary education from a public institute in Valencia in Spain. Concluding that Escape Room allows to deepen knowledge, increase motivation and curiosity, improve culture and can be used as a complementary alternative for classes [14].

A common characteristic that the results of the above-mentioned studies show is the development of collaborative learning, based on motivation and problem solving through challenges. This led to the development of an Escape Room to strengthen chemistry learning, described below.

3 Method

The present research has a mixed approach with an applied modality in which the Escape Room called "Super Escape Room" is implemented, with the purpose of generating an interactive chemistry learning environment.

3.1 Participants

The study included 40 students in the second year of high school chemistry course at a public educational institution in Ecuador. The age of the participants is between 16–18 years; of which 57.5% were women and 42.5% were men. All participants were divided into 10 teams of 4 students each.

3.2 Materials

The resources used for planning, design and execution of the Escape Room are shown in Table 1.

Table 1. Resources used for the construction of the Escape Room.

Resourse type	Resourse name	Description
Physical	Computer	Windows 10 Operating System, Intel core i5 processor, 8 GB Ram
	Mobile device	Iphone 7 plus, 32 GB storage, software version 14.4
	Calculator	Casio brand, two-line display, model fx-570 MS
	Periodic table	It contains information on chemical elements such as: atomic weight and masses, among other data
	Notebook	Formed by a set of blank sheets joined by means of a spiral
	Pen	Writing instrument containing ink
Digital	Genially	It is a platform for interactive activities https://www.genial.ly/en
	YouTube	Video sharing tool www.youtube.com
	Quitarfondo	Website designed to remove the background from png images https://quitarfondo.com
	Cerebriti	platform to create and share educational games www.cerebriti.com
	Wordwall	Website to create interactive educational resources https://wordwall.net/
	PhET	Interactive simulations tool https://phet.colorado.edu/
	Sonido mp3	Platform to download sounds http://www.sonidosmp3gratis.com/index.php
	Zoom	Video conference tool https://zoom.us/
	Google Forms	Tool to create online forms https://www.google.com/forms/about/

3.3 Procedure

The present investigation was based on the following phases:

3.3.1 Exploration Phase

At this stage, the students' and teachers' opinion about chemistry teaching methodologies was considered. An individual interview was applied to three teachers of chemistry subject, using a 10-question structured questionnaire. A survey was also conducted with 178 students, using a structured Google Forms form with 15 multiple-choice questions with Likert Scale and 7 open questions.

3.3.2 Planning Phase

After obtaining relevant data on the criteria and opinions of the participants, the Super Escape Room was designed as a pedagogical strategy for chemistry teaching. Before

construction, a survey was also conducted with students about the narrative to be used, among the different options were: Minecraft, Mario Bros, Pokémon, Avengers. Among them Mario Bros obtained the highest acceptance percentage represented by 37.9%.

3.3.3 Experimentation Phase

In this phase 40 second year high school students participated, distributed in 10 work teams, who, through their knowledge of chemistry and in a collaborative way, solved the eight challenges in four work sessions.

3.3.4 Evaluation Phase

To validate the research proposal, a survey was applied, elaborated in five dimensions: Design and Usability, Methodology, Skills Development, Emotions and Teamwork, yielding relevant data that is showed in the results section.

4 Chemistry Escape Room Design

The Escape Room, like other active methodologies, requires correct planning, where several elements and materials are incorporated generating a graphic design for an educational adventure, those are detailed in the following stages.

4.1 General Approach

The Escape Room called "Super Escape Room" was designed on the Genially platform, which contains elements such as: the narrative about the innovative rescue of the princess, enemies to defeat which have skills or knowledge according to the theoretical and practical contents of chemistry, route map where each of the enemies is found and finally the challenges to overcome that include the eight contents of the subject.

The allotted time to overcome the challenges and rescue the princess was four hours, where the members of each work team put into practice their knowledge about: the periodic table families, subatomic particles calculation, chemical symbols recognition, hydrogenated compounds formation, oxygenated compounds formulation, molecular weight calculation, percentage composition and equalization of chemical equations calculation.

4.2 The Narrative

For Super Escape Room, the Mario Bros theme was used, the same one that had a different narrative from the traditional game, because here Princess Peach was not rescued by her friends Mario and Luigi, because she had to leave the castle to overcome a series of challenges, where the student became a perfect alloyed, putting into practice his chemistry knowledge to be able to defeat the enemies and overcome the challenges.

4.3 Challenges Construction

The design of the Super Escape Room includes eight challenges designed in different technological tools and each of them was related to a proposed content. The tools used to develop the challenges were: Cerebriti, Wordwall, PhET.

As an example, one of the challenges is presented in Fig. 1. This challenge was related to the oxygenated compounds formulation, where the student carried out the activity of the Wordwall platform by selecting the correct formulas according to the names of the chemical compounds and later find the key to this challenge and defeat the enemy Hammer.



Fig. 1. 5th Challenge. Identify the correct formulas for the chemical compounds on Wordwall platform.

4.4 Route Map

This resource also includes a route map, which was designed inside the castle. In this tour the students had to overcome eight challenges according to the contents of the subject.

4.5 Final Rescue

It is the final stage of the game, once the challenges were completed, the student proceeded to open the main door, by selecting the correct key. For this activity the student used an arithmetic operation with the keys of the different challenges.

5 Results and Discussion

The results presented below represent the student's assessment of the Super Escape Room experience in the learning process. For the five dimensions analysis, a survey designed in Google Forms was applied, which contains 20 questions on the Likert scale.

About the design and usability of the Escape Room (eight items) they yielded the following data. Considering the graphic design and colors of the game, 76% of the

respondents were placed on the scale between very good and excellent. In the same way, an almost similar percentage (78%) consider that the game narrative was very good and excellent. Only 5% of the students stated that during the development of the game they had the problem of loading delay. In this sense, it is stated that the design and usability are adequate, because it took less than 3 h to 80% of the participants to be able to carry out all the activities and only 2% indicated that the challenges posed in the Escape Room were difficult.

Regarding the methodological dimension (six items), 98% of the students responded that the information and instructions in the development of the escape Room was adequate. The same percentage of students (98%) considered that the Super Escape Room allowed them to consolidate the theoretical contents and understand the practical contents of chemistry. In this sense, they indicate that the Escape Room strategy can be applied to other subjects in their student training curriculum.

In the skill development dimension (two items) it is observed that teamwork, learning motivation, communication and problem solving were the skills that were strengthened in students during the Escape experience Room [9, 12, 14]. The activity where it generated the most learning was about the equalization of equations designed in the virtual interactive simulator PhET, see Fig. 2.

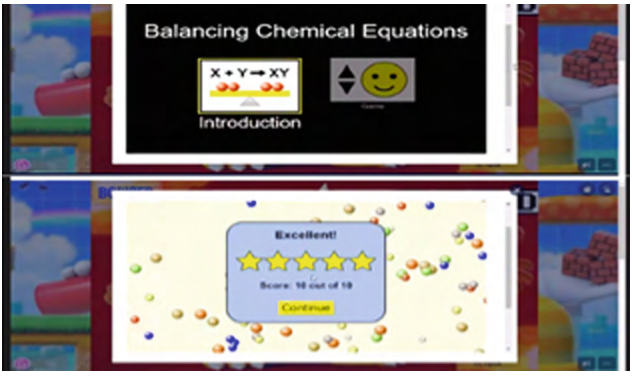


Fig. 2. PhET Plataform. 8th Challenge. Equations Equalization

Considering the feelings dimension (one item), it was observed that enthusiasm, satisfaction, confidence and peacefulness were the emotions that the participants felt during the development of the Super Escape Room [5, 9].

Finally, the dimension of teamwork (three items) showed that cooperation, respect and solidarity were the values that the participants developed during the game. The strategy of 90% of the work teams was a collaborative way during the development and resolution of the challenges of the Super Escape Room [9].

6 Conclusions

From the results obtained, it can be concluded that the Escape Room is an interactive learning strategy, where the student is the protagonist of its learning by solving

problems to strengthen the theoretical and practical contents of the subject. The Escape Room allows students to generate transversal skills such as: teamwork, increasing their motivation and communication. In the same way, generate positive emotions such as satisfaction and trust and strengthen the cooperation values and solidarity [15, 16].

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Information Dissemination of COVID-19 by Ministry of Health in Indonesia

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Abstract. This study aims to find out how the Indonesian Ministry of Health disseminates information about COVID-19 in Indonesia using the Twitter account @KemenkesRI. This research uses descriptive qualitative research. Data analysis using NVivo 12 Plus software, data retrieval via the Ministry of Health's Twitter account via NCapture from NVivo 12 Plus with Web Chrome. The data is processed with the cross tab feature to automatically calculate the required main statistical tests with meaningful comparisons and analysis of indirect variables. The Crosstab Query feature is to enter code (manual, generated, etc.), text data, and numeric data in variables and pattern data. At this stage, an automatic calculation is found between all data related to the dissemination of COVID-19 information. Furthermore, using the Word Cloud feature, words that often appear in data searches or display terms are discussed. and the last one is looking for a cluster related to the @KemenkesRI account. This research reveals the Indonesian Ministry of Health's tweet regarding COVID-19 on their Twitter account. The findings also include updating of COVID-19 data, health protocols, vaccinations and adaptation of public policies. In these four indicators, there are 363 tweets about vaccination indicators, the second is an indicator about the Covid-19 case data update of 265 tweets, the third is a health protocol indicator with 72 tweets, and the last is an indicator about public policy with 63 tweets.

Keywords: Information · Covid-19 · Social media · Government · Public policy

1 Introduction

Since December 2019, various "unknown infective agent pneumonia" cases connected to the native food wholesale market were reported in urban center town, Hubei Province, China. Coronavirus (severe acute metabolism syndrome coronavirus two, or SARS-CoV-2) was suspected as the leading cause, with the Phinolophus bat as an alleged origin. In precisely two months, the virus had unfolded from an urban center throughout China and thirty-three alternative countries [1]. On March 2, 2020, President Joko 'Jokowi' Widodo declared the primary (and second) positive cases of two citizens, a 31-year-old and 64-year-old woman [2].

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 61–67, 2022.
https://doi.org/10.1007/978-3-030-85540-6_8

According to information from the United Nations agency, so far (March four, 2021), there have been 353,834 total cases of COVID-19 in the state. From this information, 18 out of 221 countries were infected with the COVID-19 virus [3]. This information has become a priority of the Ministry of Health, which should be communicated to the general public for health education. In distributing this data, the Indonesian Ministry of Health used social media [4].

Social media is a replacement for communicating and sharing data associated with the disease. It permits a broader kind of data source to be disseminated, for the community to assist one another through data sharing and emotional support, and to stay in reality with one another [5]. The government's social media has a crucial role in disseminating data (significantly associated with COVID-19) and may be used as a way of community interaction with the government or e-government [6].

In this case, the Indonesian Ministry of Health has disseminated data associated with COVID-19 on their official Twitter account with 488.5 thousand followers. The tweets are mainly about{the information|the knowledge|the information}, case updates, 3M (wearing a mask, maintaining distance, washing hands), maintaining a healthy life, and vaccinations. From this rationalization, it is interesting to check how the Indonesian Ministry of Health creates patterns through their Twitter account in human action and provide data about COVID-19 to the community.

2 Literature Review

2.1 Public Communication of Government

All voters have the correct access to government info because they will participate in politics. The correct information is enshrined during a range of international treaties and Article 19 of the Universal Declaration of Human Rights. The voters' access to public authority info is called the freedom of information act. It plays a significant role in providing residents information to create proper political selections [7].

The government must use integrated communication, which is defined as communication in use: customer integration and the understanding of all messages from any source, driven by the company or originating from other sources, the customer perceives as communication, forming a use-value for him for certain things [8].

Communication through social media could be an advanced method involving several stakeholders and public participation and interaction. Rising health emergencies area units seemingly become world and native problems. Thus, effective health and risk communication should also consider the political and cultural context during which social media messages will be received and understood [9].

Implicit in politicians' general public on social platforms should be transparent with the public by being responsive. Thus, for each politician and the public, social media has become a platform for depicting celebrities as a variety of "intimacy, genuineness and access, besides, because of the construction of an externals" [10].

2.2 Social Media on Government

Social media refers to voters who use online platforms to specify their state affairs and participate in political activities to influence public policy. ICTs, particularly internet-based channels, permit voters to urge information concerning what the government is doing and then promptly replicate their views back to the political method. Since the beginning of the web era, similar ideas have appeared within the literature, like electronic democracy and online participation [11].

One of the most options of social networks is that voters can participate in political debates voluntarily. This digital media transforms antecedently passive customers into active users who will produce their content and specific their views and interests on political problems. Social media connections' prevailing social network permits timely and period resources to unfold speedily through the user's network. Additionally, multimodal interactive content supported by a combination of facts and values will increase risk awareness and strengthens readiness by investing in public issues and might drive compliance [12].

Different social media, like blogs, microblogging, sharing services, text messages, discussion forums, and social networks that may directly interact with their voters, are presently utilized by government departments in varied countries. Control and implementing government policies for the great of society by increasing productivity and overall public services is at the core of e-gov coordination [13]. The government's social media is a replacement wave of technology adoption. The government on social media platforms is not {anylisn't any} longer seen as a choice however as a replacement customary. Therefore, in e-government analysis and follow round the world, the government's social media is turning into an important topic. Social media's primary purpose is to make new ways to interact with the general public and increase participation and collaboration among voters. Understanding user views in social media communication has received more significant attention because social media has become an essential platform for organizations to act with users [14].

3 Research Method

This research used descriptive qualitative research. Data analysis implemented NVivo 12 Plus software, data retrieval via the Ministry of Health's Twitter account via NCapture from NVivo 12 Plus with Web Chrome. The data was processed with the Crosstab feature to automatically compute the required main statistical tests with meaningful comparisons and indirect variables analysis. The Crosstab Query feature was to enter code (manual, generated, etc.), text data, and numeric data in variable and pattern data. At this stage, an automatic calculation was found between all data related to the dissemination of COVID-19 information. Furthermore, using the Word Cloud feature, the words that often appeared from the data searches or view terms would be discussed. This research revealed the Indonesian Ministry of Health's tweets related to COVID-19.

4 Results and Discussion

4.1 COVID-19 Information Dissemination Activities

Dissemination of information about COVID-19 tweeted by the @KemenkesRI Twitter account is relatively good. Their account is also active in updating news about COVID-19. The following picture is news spread about COVID-19 from June 2020 to March 2021 (Fig. 1).

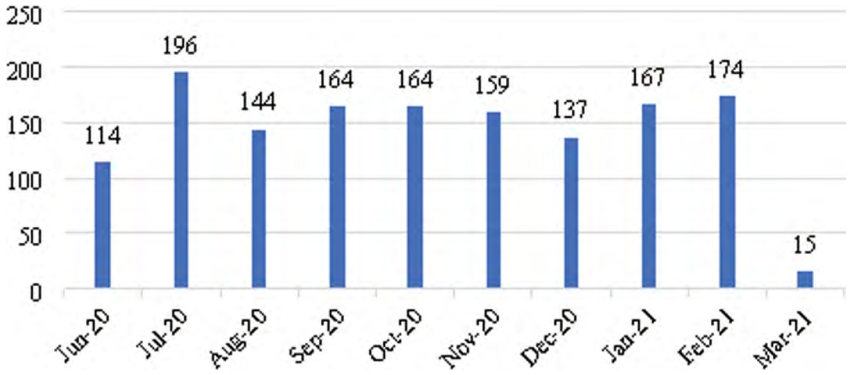


Fig. 1. Updating news about COVID-19

The data above is taken from the Ministry of Health's official Twitter account for the last ten months, from June 2020 to March 2021. The most tweets from the @kemenkesRI account were in July 2020, which is 196 tweets. In February 2021, they tweet 174 posts, and in January 2021, 167 tweets are posted. The following month, the most tweets are in September and October with 164 tweets and in November with 159 tweets. During this pandemic, @KemenkesRI always tweets about COVID-19.

4.2 COVID-19 Information Indicators

Four indicators can be discussed in the dissemination of information related to COVID-19 from the @KemenkesRI Twitter account. These indicators are Data Update, COVID-19 Public Policy, Health Protocol, and COVID-19Vaccination and can be seen in the following figure (Fig. 2).

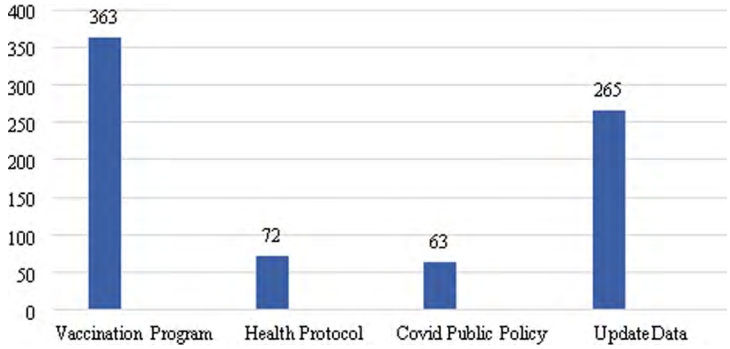


Fig. 2. Indicators discussed from COVID-19.

Of the four indicators discussed from this account, the most tweeted is the COVID-19 vaccination program, with 363 tweets, followed by the COVID-19 case update with 265 tweets. The third indicator is about the Health Protocol, with 72 tweets, while the last is about Public Policy with 63 tweets. The vaccination program's tweets are the highest because the Ministry of Health is conducting a campaign to attract the community to participate.

4.3 The Most Frequently Used Words Tweeted by @KemenkesRI

There are several words, hashtags, or accounts that @KemenkesRI often tweets. The following figure shows the most frequent words tweeted by the account (Fig. 3).



Fig. 3. Word Cloud of Kemenkes RI.

The Indonesian Ministry of Health tweets 578 most often appeared words on their Twitter account with the word 'covid' of 564 tweets, revealing that the account has been paying attention fully to the COVID-19 issue.

4.4 Cluster Analysis of @KemenkesRI

The @KemenkesRI Twitter account is divided into 3 clusters. The following is the result of cluster analysis (Fig. 4).

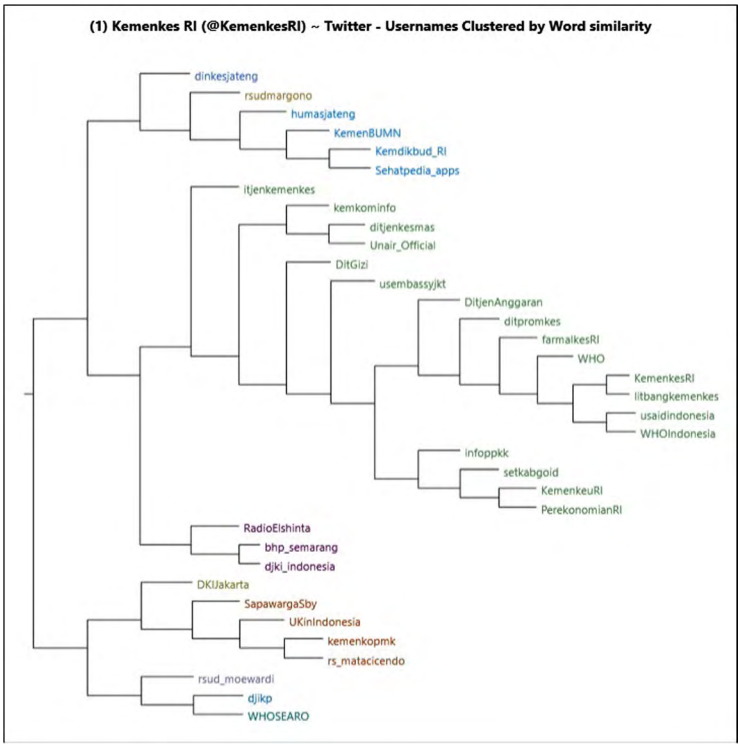


Fig. 4. Cluster analysis of Kemenkes RI.

From the data above, it can be concluded that the Twitter account of the Ministry of Health has an integrated institutional communication relationship with several sectors such as the inter-governmental sector, the private sector, and the NGO's sector. The government sectors that communicate with the Ministry of Health in the Ministry of Education and Culture of the Republic of Indonesia, the Ministry of Finance of the Republic of Indonesia, the Ministry of Communication and Information, etc. The private sector communicating with @KemenkesRI is Elshinta Radio. And the last sector is NGOs, such as USAID Indonesia, the UK in Indonesia (British Embassy), etc.

5 Conclusion

The Indonesian Ministry of Health, through its official Twitter account @KemenkesRI, has disseminated information about COVID-19 quite well. Indonesian people who follow the @KemenkesRI account get complete details about the data. In sharing information about COVID-19, the Ministry of Health have maximized its Twitter account, seen from four fulfilled indicators. The Ministry of Health updates the data about COVID-19 as often as possible so that the public knows the exact number of infected cases. To prevent COVID-19, the Ministry of Health also disseminates information to follow

health protocols and make policies. Currently, the Ministry of Health is also conducting a campaign on vaccination to prevent or reduce COVID-19 cases.

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Strengthening Mathematical Skills with M-Learning

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Abstract. The COVID-19 pandemic transformed education from face-to-face to virtual. This accelerated the creation of new learning environments based on the everyday use of mobile devices, presenting new challenges for education. Emerging technologies today drive mobile learning or m-learning. This research focuses on the development of a mobile application that seeks to strengthen the mathematical abilities of whole number empowerment in high school students in a blended mode. The application includes four missions that make up an interactive game, in which the player has three lives and accumulates points. Mate-potencia Olympics faces two players, who must meet the challenges of each mission, the winners go to a second round, until they have the winner. Students learn the process of calculating square powers, identifying each of its elements, allowing dynamic, ubiquitous and flexible learning.

Keywords: M-learning · Emerging technologies · Mathematics · Empowerment

1 Introduction

Education worldwide underwent a transformation due to the COVID-19 pandemic. The change from face-to-face to virtual, as a measure against COVID-19 and the use of technologies in education such as platforms and mobile applications, has been fundamental for the teaching-learning process [1]. Likewise, UNESCO in March 2020 presented the "World Coalition for Education" program, to help nations find innovative solutions according to their social context, improving educational practices in the distance mode with the use of mobile technologies, radio and/or television to reach everyone with educational content [2].

To implement ICT in education, they must be adapted to the teacher and student so that both identify the usefulness of the technologies and achieve an efficient relationship between the subject, who dictates it and who receives it [3]. In this sense, the teacher ceases to be the transmitter of information as a source of knowledge, to be the mediator and guide of the student [4]. Likewise, the student becomes responsible for selecting,

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 68–73, 2022.
https://doi.org/10.1007/978-3-030-85540-6_9

using, and organizing the unlimited information they have access to in order to learn, create their own knowledge and share it with others [5].

The use of mobile technologies offers great potential for learning, since open resources can be used or created according to the requirements of the educational program, the educational needs of the students and/or the expected learning outcomes [6]. These devices allow the sharing, transmission, and dissemination of classroom content, where the identified trend is the use of platforms and applications for the distribution of information and the development of the evaluation process [7].

The incorporation of ICT in the educational process, converge to education and learning environments in mobile systems, promoting new education models such as Mobile learning or mobile learning, defined in general as learning mediated by mobile devices allowing access continuous information and communication between students and teachers [8], favoring meaningful and independent learning [9].

Teachers have been in charge of promoting the pedagogical use of mobile devices, with a view to facilitating the acquisition of learning in students, activities such as searching for information through the internet have been promoted to enrich thematic content, review multimedia files, download applications and games that strengthen the theoretical and practical understanding of what has been learned with the teacher [7].

In this sense, Rivero and Suárez [10] recommend that it is important that the classes are designed in such a way that they integrate the use of the application with an educational purpose that allows to achieve the curricular objectives, generating an educational technological balance; Likewise, a permanent pedagogical accompaniment is implemented to detect and correct the needs and limitations of the student; and at the same time promote the development and application of technological tools in educational institutions through the creation of institutional sustainability policies.

Learning is the result of the interaction between the clear, stable, and relevant anchors present in the educational structure and that new information, these ideas are enriched and modified, giving rise to new, more powerful and explanatory ideas that will serve as the basis for future learning. [11], but this requires a work team and a plan to improve ICT skills in teachers and students. In this way, Mobile learning supports the development of student autonomy, strengthening human and social development.

The development of mathematical skills, using M-learning, is the basis of this research, through an application that allows students to understand the concepts of empowerment and in a playful way the learning process is more dynamic, attractive, and participatory [12]. In this context, an application for smartphones is proposed that aims to stimulate memory and strengthen mathematical ability in students.

2 Technological Proposal

To stimulate memory and strengthen mathematical ability in students, Mate-potencia is proposed. This application was developed on the MIT App Inventor platform. The platform allows the creation of mobile applications for educational purposes based on block coding built on Google Blockly for smartphones or Tablets with Android and IOS operating systems, the interface consists of two main parts: Designer and Blocks.

2.1 Develop Skills Around Whole Number Empowerment

The Mate-potencia proposal has four missions developed in various environments that seek to strengthen students' mathematical skills. So that the user can easily explore the application, the menu screen lists its functions in an attractive visual and orderly manner as four missions. In the design, three horizontal arrangements were used, where interfaces such as image, buttons and labels were distributed, as well as two non-visible means such as the clock and sound that supported the programming for proper operation, as can be seen in Figs. 1 and 2.

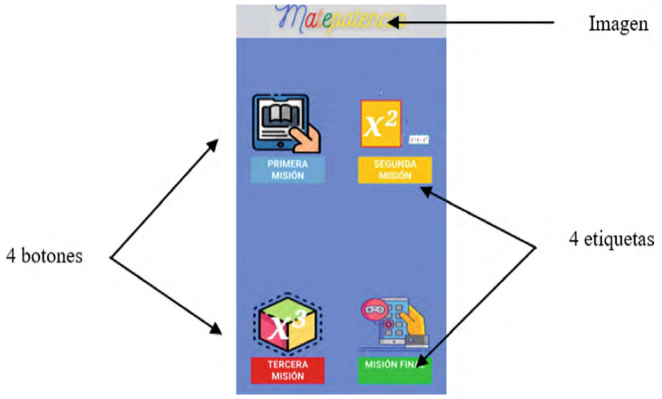


Fig. 1. Menu screen layout

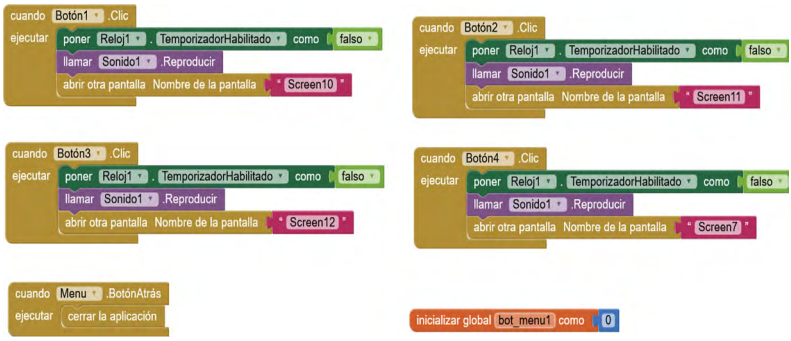


Fig. 2. Menu screen programming block

First mission: By clicking on the first mission link, the user will enter the SELF-LEARNING window, where the theoretical content and activities that can be carried out called reinforcement are presented.

Second mission: It consisted in the design of the first level of an interactive game that allows the user to understand the process to calculate square powers, by identifying its elements (base and exponent). The programming of the design components to operate the square powers game was carried out with the use of variables that help to start, check the result with the count of errors and hits, and the end of the game, as detailed in Fig. 3.

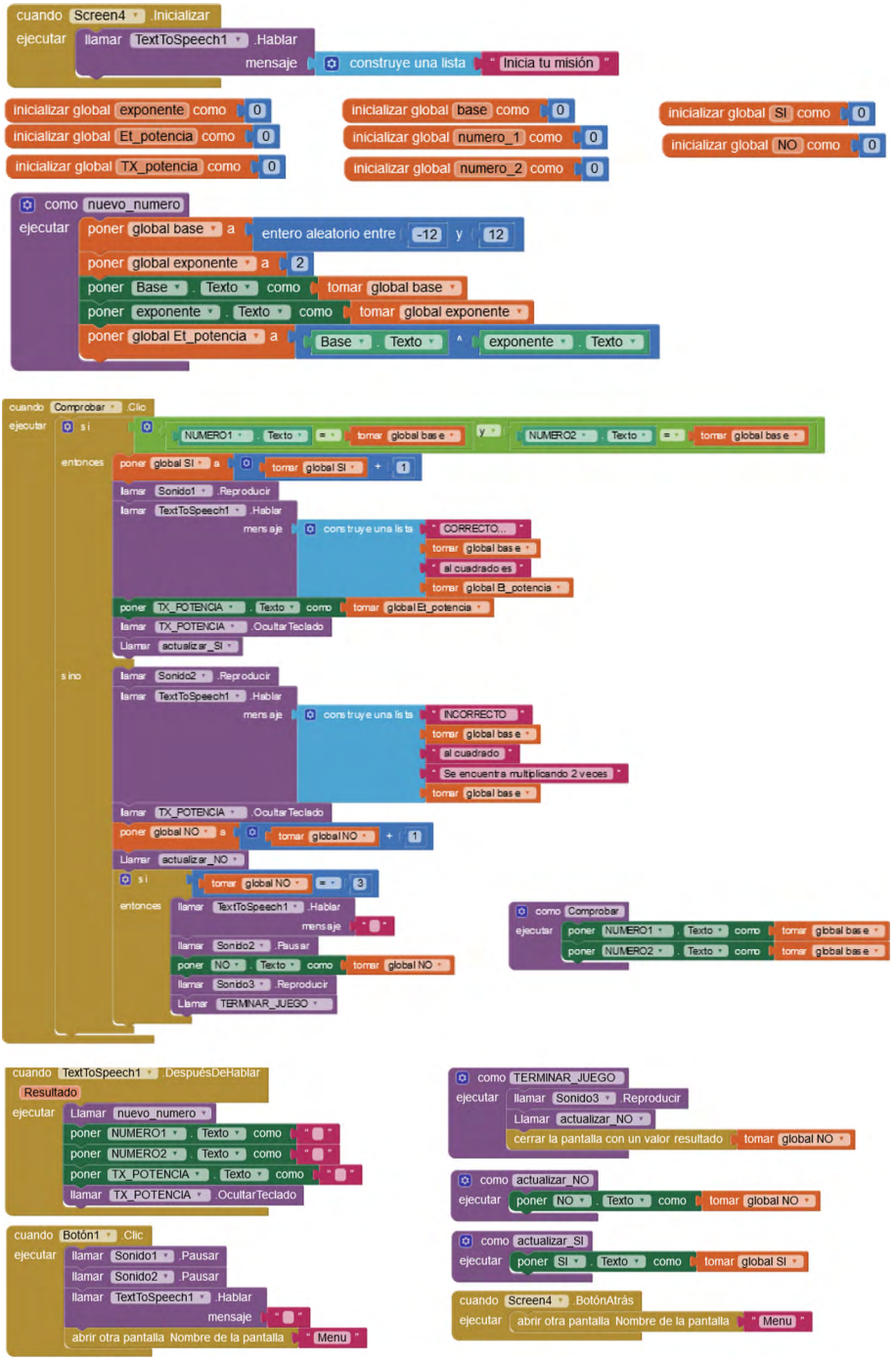


Fig. 3. Programming to start the second mission.

Third mission: The design of the next level of the game focused on demonstrating the process to calculate and read cubic powers, programming the components used in a similar way as the previous phase.

Final mission: Presenting the final level of the game focused on the evaluation of the knowledge acquired by the users in the previous missions, especially the mental calculation of the square and cubic powers, being programmed in such a way that the user is challenged to get several points without losing the 3 lives you have.

3 Conclusions

The strengthening of mathematical empowerment skills with whole numbers is affected by the lack of resources that help in a fun and playful way. For this reason, we present the Mate-potency application for smartphones, which contains four missions to develop memory and mathematical skills in solving powers with whole numbers.

M-learning is ideal for the use of these devices for educational purposes, since students have this technology, which contributes to their training.

In the future, a longitudinal study will be developed to evaluate the effectiveness of the application, with measurements before and after with a control and experimental group.

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Understand the Importance of Garments' Identification and Combination to Blind People

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Abstract. Throughout our lives, we are very dependent on the ability to see the "world". Everyday our eyes capture images that enable us to describe our ideas, our tastes and influence our identity. How we dress up is determined by our personal taste, mainly fed through our own eyesight. Once esthetics are supported by our vision, blind people is limited while performing tasks such as purchasing, selecting and matching outfits. These are considered easy tasks for visually enabled people and difficult tasks for people that cannot see. Therefore, within this scope it has been developed and distributed a survey to all the departments of the Association of the Blind and Amblyopes of Portugal (ACAPO). The survey has two main objectives: to recognize the importance of identifying and combing garments and to assess the needs in the development of clothing identification and combination systems that support blind people.

Keywords: Survey · Blind people · Clothing recognition

1 Introduction

Visual impairment affects thousands of people worldwide. According to the 2011 census, in Portugal, there are about 900.000 persons with visual impairments, of which, around 28.000 are blind [1].

Our life is dominated by vision. Much of the information received by the brain reaches it through the eyes. It is through the sense of vision that we perceive everything around us, thus allowing to build ideas, tastes or identity. All of these concepts are reflected, among others, in the way we dress.

Currently, when purchasing or choosing clothes, blind people are dependent on their relatives, friends or support center professionals. These tasks are so easy for those who see but so difficult for those who have little or no vision. Dressing can be a difficult and stressful task in the daily life of blind people.

At the moment, there are some fashion apps to manage the clothes, create outfits, and plan what to wear that could be used for blind community also, even though they are

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 74–81, 2022.
https://doi.org/10.1007/978-3-030-85540-6_10

not focused on the blind [2–5]. Electronic devices such as ColorTest 2000 and Colorino has come to fill the difficulties of the blind in the distinction of colors. Both devices have voice feedback and can detect light source [6, 7].

In the literature, there are few projects focused on this area for the blind community. It was identified a project that recognize patterns of clothing being able to identify 11 clothing colors and recognize 4 categories of clothing patterns [8]. Other one that, suggests a form of clothing combinations of complex patterns for visually impaired people [9], as well as another project that allows to classify the type of pattern of garments through extracting their characteristics by a camera [10].

According to the research undertaken there are technological resources that, directly or indirectly, can help in the identification of colors, patterns, garments, but they do not focus on the aesthetic aspect of combining and identifying garments. So, within this scope a survey was designed and distributed to all the delegations of the Association of the Blind and Amblyopes of Portugal (ACAPO) in order to assess the need to develop a system to identify and combine the garments for blind people. Following the previous work [11–16], the main objective of the developed survey is to recognize the importance of identifying and combining garments by blind people and to identify the technologies and forms of assistance that have been used, or may be used if available, by this community.

This paper is organized in four sections: Sect. 2 explains the methods used to collect data; Sect. 3 analyses the results obtained; the conclusions and future work are addressed in Sect. 4.

2 Methodology

In order to fulfill with the proposed objectives, the perception of the importance of identifying and combining clothing for blind people survey was developed and applied. In this chapter it will be described the sample and survey methodology.

2.1 Sample

It was requested to the blind associates of the ACAPO to cooperate in the study filling the survey. The survey was delivered by email. The data was collected from July to September 2020 and the participation was voluntarily and anonymous. A total of 26 participants replied to the survey, in which 23 full responses fulfilled all the conditions set and only 3 did not satisfy the conditions set. In the present study, all the analyses were made considering the full responses.

2.2 Instrument: Survey - Perception of the Importance in Identifying and Combining Clothing for Blind People

The design of the preliminary version of the survey was developed according to a need identified by ACAPO, regarding the identification and combination of garments in blind people. The development of the survey has fulfilled the following stage process: (1) design of the preliminary version, (2) pretest of the preliminary version, (3) development

of the final version incorporating the suggested improvements, and (4) delivery of the survey.

The pretest of the preliminary version consisted of validating the questionnaire prepared by the research team to the representatives of ACAPO, including a blind member. Afterwards, the development of the final version incorporated the suggested improvements detected during validation. These improvements consist in reorganize the method of response for determined questions in order to be more user-friendly to answer. Finally, the survey was distributed to all the delegations of the ACAPO in Portugal. These delegations have sent the survey by email to the associates.

The final version of the survey consisted of a total of 25 questions divided into 5 main parts: (1) Personal identification, (2) Identification of the type of disability, (3) Clothing, (4) Technology and (5) Research and development.

The part of the Personal identification included questions in order to gather information regarding the characterization of the participant, like age, gender, academic qualifications and current occupation.

The second part of the questionnaire, regarding the Identification of the type of disability enables the analysis of diseases that caused blindness in the participants, as well as the age group in which the diseases occurred.

The third part, Clothing, includes 6 questions to identify the importance and concerns that blind people has around what do they do to get dressed, choose and how they shop their clothes. In this subject, some questions were presented as statements. The answers were based on a 5-point Likert scale of agreement, importance or frequency.

The fourth part, Technology, includes 3 questions that aim to assess the knowledge, usability and satisfaction that blind community has in relation to the available supportive technologies. However, it is also possible to assess the proximity that this community has within this technology.

The fifth and last part, Research and development, includes 3 main questions and other 2 complementary. In this section, it is intended to assess the availability and the interest in developing a technology that supports the blind community identifying and combining clothes. Moreover, we also are interested in knowing how blind people would like this technology to be available. The suggestions and opinions of the participants were taken into consideration in the final version.

3 Results and Analysis

The data collected using google forms were stored in a table and analyzed using the statistical software SPSS (Statistical Package for the Social Sciences) version 22. At this initial stage of analysis of the collected data, a descriptive statistics with data represented and summarized as percentages was considered.

3.1 Participants Characterization

In order to obtain the characterization of the participants in this survey, 4 variables were defined: age, gender, academic qualifications and profession.

The age of the participants denotes that there is no uniformity between the age groups, with the age between 45 and 54 years old, representing 52.2% of the answers, the youngest being 18 years old, and the oldest 65 years old.

Due to the wide range of participant's age, during the analysis of the survey, the variable age was grouped into two groups, one for the age less than or equal to 44 years and the second to values equal or greater than 45 years.

The majority of the participants were female (73.9%).

Most of the participants have higher education (43.5%) and 26.1% have at least nine years of secondary education.

In the analysis of the professions, most of them are unemployed (30.4%), which may represent a hindrance to integration of this population in the labor market. Restaurant and administrative services were the following areas with 13% each. Other category include all retired people and students, representing 17%.

3.2 Identification of the Type of Disability

The second part of the questionnaire contains two questions enabling each participant to identify the causes and types of disease that caused to the participants' loss of vision:

QII.1: Since what age are you visually impaired?

QII.2: What caused your disability?

On the basis of the responses received, the majority (69.6%) were blinded during the first year of life. This shows that they do not have basic notions about the "world" around them.

Identical value was obtained regarding the reason for the loss of vision, that is, 65.2% had loss their vision due to congenital disease, and 8.7% as a result of an accident. The remaining 26.1% refers acquired disease as cause of vision loss.

Congenital disease occurs during pregnancy, which explains the high number of vision losses before reaching one year of age. The participants characterized their type of disease with regard to congenital disease and acquired disease, with glaucoma and retinopathy being the main causes of vision loss, respectively.

3.3 Aesthetics and Clothing

More and more, aesthetics is present in our lives. The way we dress has a big impact on our daily lives and is crucial to our well-being. From the importance that society gives to the way we dress to the importance of choosing clothing for the workplace in order to help convey the right and appropriate image for the context in which we are inserted. So, in the third part of the questionnaire, three statements were considered:

QIII.1: Vision is one of the senses that dominates the life of human beings. It allows them to know and perceive the world around them, while giving meaning to objects, concepts, ideas and tastes.

QIII.2: How to dress and the style we prefer for different occasions is part of someone's identity. Blind people do not have this sense, and dressing can be a difficult and stressful task. With the advancement of technology, it is important to minimize all the limitations of a blind person whilst organizing their own clothing.

QIII.3: The lack of knowledge about the colors, the type of pattern or the condition of the garments makes this a daily challenge, in which the current resources are not the best.

And the following three questions:

QIII.4: Are you worried about matching garments?

QIII.5: How often do you need help buying clothing?

QIII.6: Where do you buy your clothes?

Due to the size of the sample, for all statements, the scale was recoded so that only two groups were possible: "agree" and "disagree", showing a positive or negative response for each statement. Figure 1 shows the distribution of results in the different statements.

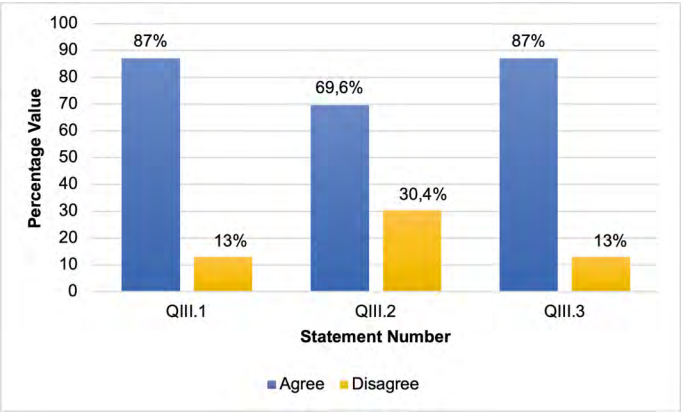


Fig. 1. Positive and negative response distribution for each statement.

The majority of participants recognize the sense of vision as the key to the attribution of meanings and recognition of everything that surrounds us. The importance of aesthetics as a definition of our identity is also in agreement among the participants, as well as the daily difficulties experienced by participants due to the lack of resources.

As expected, all participants have reinforced their importance in combine clothing, the majority of which (73.9%) say that they frequently seek help to shop their clothes, mainly from family members, support center professionals and CAVI (Support Center for Independent Living).

When asked where they buy their clothes, all participants referred physical stores, with 39.1% of them also referring to do shopping online.

3.4 Technology

Certainly, the technology in this field has evolved considerably; however, it is necessary to understand whether there is enough technology to minimize the obstacles faced by these people in their daily lives.

So, in the fourth part of the questionnaire, after the identification of the device and system used, two questions were considered:

QIV.1: Are you aware of any technology for clothing identification?

QIV.2: How satisfied are you with the technology available on this topic?

The participants, in their majority (65.2%), demonstrate to have a knowledge of clothing identification technologies. They identified apps on their smartphones as their main source of aid to detect colors. As an alternative, the same users opt for Colorino. However, only 26.1% demonstrate being satisfied with the existing technology resources. This result, in a way, is important and motivating for the continuity of the work.

Around 89% mentioned to use smartphones, 72% a laptop, 33% uses mobile phones and 11% tablet devices. Most smartphone users have the IOS operating system.

3.5 Research and Development

Aesthetics not only characterize the image and appearance of our body, but also our well-being, self-esteem and optimism in "day-to-day" life. The research and development of a solution in this project seeks these characteristics.

Finally, in the fifth part of the questionnaire, three main questions were considered:

QV.1: Would it be important to develop *something* that would make it possible to identify and combine clothing?

QV.2: How likely is it to use a technology that includes the act of identifying and combining clothing?

QV.3: Did you need help in completing this survey?

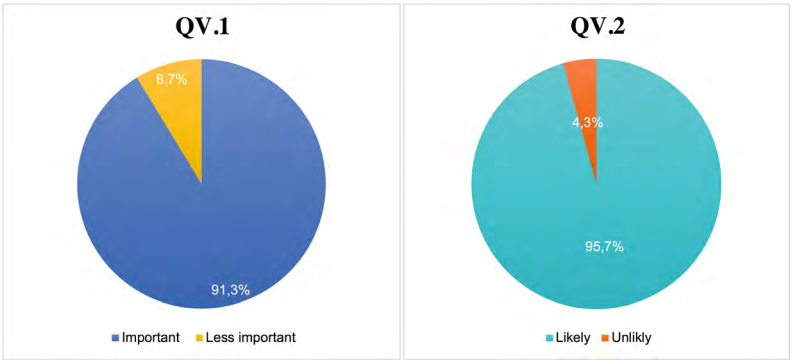


Fig. 2. Results distribution for QV.1 and QV.2.

According to Fig. 2, most participants (91.3%) agree that a framework should be developed to help identifying and matching garments.

According with the previous answer, almost all participants (95.7%) are willing to use technology that helps them to identify and combine clothes. When choosing the platform to use the technology, the smartphone and the laptop were the main choices with 43.2% and 35.1%, respectively.

Lastly, and in order to answer the survey only 17.4% states that sought some help to fill out the questionnaire.

4 Final Remarks

Based on the information collected and analyzed to this stage, the results on the first application of the survey to the blind associates of the ACAPO population show a positive attitude that reenforce the importance to develop tools that allow the identification and combination of garments. Moreover, about 95.5% of the respondents are available to use technology that helps them in this task.

Although the sample dimension used in the analysis can be considered small ($n = 23$) to be representative for the national blind people population, it is authors believe that the results so far collected reinforce that the aesthetics of clothing is of central importance in the life of blind people, who are increasingly inserted in the labor market, following the major global and European directrices of inclusion.

Through the survey undertaken by the participants, it is possible to conclude that not knowing colors, patterns and clothes' overall condition is a challenge that blind people faces every day. This comes to emphasize the need to identify and combine clothing.

Despite of all the difficulties, the offer of different technologies and support is still very limited to this community. So far, mobile phone applications and Colorino remain the leading sources of support used by blind people.

The participants recognise the importance in identifying and matching clothes. They are willing to make use of technology, available in smartphones and laptops, to enhance their ability in identifying and combining clothes.

In the comments, the participants demonstrated their enthusiasm and willingness to collaborate in this research.

This paper highlights the need to overcome a problem already identified in previous researchs, showing it's importance. Also, it shows how much the people is willing to make use of technology to support them with the presented challenge.

Acknowledgments. This work has been supported by FCT – Fundação para a Ciência e Tecnologia within the R&D Units Project Scope: UIDB/00319/2020. The authors would like to express their acknowledgments to Association of the Blind and Amblyopes of Portugal (ACAPO).

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International Employees' Perceptions and UX Design Utilization in Online Learning Development

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Abstract. Online learning is a cost-effective way of promoting social inclusion and enhancing the work-life economy. International employees and higher education students can find that they have limited opportunities to access comprehensive supplemental training opportunities, related to employment, in Finland. Tailored services based on UX design can be beneficial for their supplemental studies. This paper explores key elements identified on the basis of UX design, and how these elements can be utilized to develop effective online learning designs. An innovative case design was implemented in a Finnish firm (with 270 service users) between 2015 and 2019. The key design elements identified relate to types of accessibility, namely pedagogical, lingual, technological and economical. The study explains noticeable improvements in the overall process due to UX design utilization, such as flexibility, cost-effectiveness, user-empathetic solutions and an interactive learning experience. The practical implications of this service include enhancing required competencies and strengthening sustainable work culture.

Keywords: Online learning · International employees' · User experience design (UX) · Accessible learning

1 Introduction

Online learning has been in full swing in the recent past, and the COVID-19 era has highlighted its importance, effectiveness and drawbacks when it is mishandled [1]. Although the virtual medium of online learning is not a new concept, its effectiveness for people at work is undeniable due to its flexibility and accessibility [2–4]. Moreover, the COVID-19 pandemic has accelerated usage of online learning solutions, but these solutions are still adapted in traditional learning, e.g., degrees, certificates and course-based learning, and they no longer respond to changed socioeconomic situations in working life [5–7]. Educational institutions need to design their own business services, and better use could be made of planning and joint development.

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 82–90, 2022.
https://doi.org/10.1007/978-3-030-85540-6_11

User experience (UX) design can help to provide an effective and pleasant learning experience for working people [3]. Enhancing workplace skills is also a financial issue. It requires various service innovations to deliver services cost-effectively, keeping in mind the workplace's budget limitations [3, 8]. Educational institutions need to commercialize their services to firms and promote collaboration and joint planning. This situation specifically poses a challenge for those who want to continue their education and busy work life side by side. Flexible work-based learning is a megatrend of the present era in developed countries and is pictured as a labour-shortage solution [5–7]. In light of the current situation, it is important to design online training solutions in collaboration with firms and service users to maximize the learning results [2–4]. This will enable service design to be a cost-effective, accessible, pleasant learning experience, which brings the best possible benefits to the user and the user's work community.

The main purpose of UX is to create user experiences that improve and increase people's working, communication and interaction [9]. UX study explores how a better experience leads to a better outcome, such as making the use of some services a better experience than before, and it helps in generating a better art of interaction between all parties in the service development, using technological solutions [9]. UX has traditionally been used to emphasize different aspects of technological design. In the education field, it has been used to design educational solutions with artificial intelligence (AI) solutions [3], but there is limited research on UX design in interactive online learning for international workplaces.

Education has a relationship to labor availability, as organizations in developed countries suffer from a lack of experts in different professions, as organizations in developed countries suffer from a shortage of experts in various professions. The situation is no different in Finland, ranked as the most innovative country in the world [10]. As a matter of fact, 178,000 municipal employees will retire between 2021 and 2030 in Finland. Although the country attracts international talent in the form of students, some firms avoid hiring people with a foreign background, despite recruitment issues, due to various problems related to language and cultural differences after their graduation [7]. Due to the Finnish language being unique and given the prevailing recruitment issues, Finland is unable to compete with Canada, the UK, Australia and the USA when it comes to attracting experts and skilled people around the world. To keep the best professionals in Finland and avoid a brain drain, it is crucial to provide solid incentives and promote the capacity of organizations and society to absorb existing talent [11]. The development of better and more accessible online learning services through UX design research is paramount and can strengthen workplaces' capacity to absorb labour and attract new skills. Regional economies are also likely to benefit [3, 7, 12].

The objective of this study was to use a UX design approach to gain a better understanding of international employees' experiences as online learners. Section 2 presents the background to the study in terms of relevant literature. Section 3 introduces the research design, methods and data. Section 4 and 5 present the research results and discussion, respectively. The last section covers the conclusions, implications and limitations of this study.

2 Related Research

Unemployed immigrants participate in state-supported immigrant training in Finland [13]. Immigrant training is tightly regulated. Periods of employment and career paths are usually long [14]. Today, solutions are being sought from parallel processes; for example, language, culture and human skills can be learned in the workplace, and different talent programmes have been developed [3, 4]. Industries that compete for top talent already provide language and cultural training, but for micro firms and SMEs, services are still very expensive [2–4]. One solution is to create joint ventures for online learning, which also has an advantage in terms of cost-sharing. The possibility of combining different service users is also an advantage associated with online learning [15].

Online learning before and after COVID-19 has challenged service users and educators to improve students' conditions for learning. The importance of UX increases as online-learning becomes more commonplace and the learning experience is talked about in the context of lifelong learning [16]. AI-based solutions designed with UX provide an economical and resource-saving approach to online learning in the workplace, and optimal customization can be achieved by co-designing [17–19]. The capacity of sustainable employment should improve [7].

3 Research Design

User experience (UX) design promotes understanding of users' experiences and can improve the design of relevant services [9]. This study is focused on online learning solutions for international employees and firms via UX design. The research question for this study was *"How can UX design be used to identify key elements and how could these be utilized when developing an effective online learning design?"*.

UX design [9] can be located within a design science research (DSR) framework [20]. DSR studies support a pragmatic research paradigm that calls for creation of innovative artefacts to solve real-world problems and enhance online learning processes. The process is divided into three cycles: the Relevance Cycle, the Design Cycle and the Rigor Cycle. The Relevance Cycle inputs requirements from the contextual environment and the user experiences of Service User Personas. Design errors and shortcomings are identified in the Relevance Cycle, and these inform the Interaction Design Cycle. The Interaction Design Cycle [9] supports a research activity for the construction and evaluation of design artefacts and processes [20] (Fig. 1).

The "Language Gym" is an innovative online learning design produced by a private firm in Finland. The Language Gym was implemented from 2015 to 2019, and in 2020, it was sold and developed further under the name "Suomi-Hubi". The dataset was based on 270 language learning customers working for 14 different firms. There was a total of 87 usable responses. Inquiries, phone interviews and delayed queries were collected between 2015 and 2020 from 221 Finnish learners, 37 English, 3 Urdu, 2 Russian and 7 Chinese learners, who, all together, spoke 29 different mother tongues [21, 22]. Service users were studying online in regions of Finland (90%) and in 16 other countries (10%).

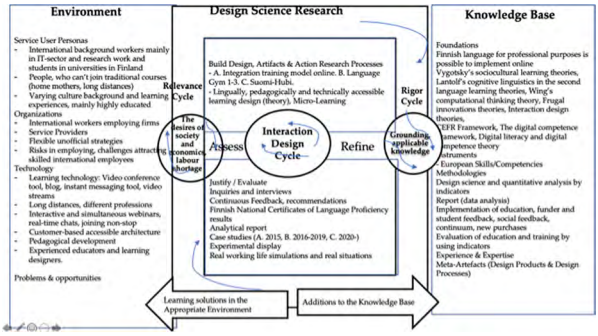


Fig. 1. Service User Personas placed in a design science research framework. The figure lists significant artefacts in the case of the "Language Gym" (2015–2019) and Suomi-Hubi starting in 2020 [9, 20].

User Personas included the following: international employees studying Finnish (58%), especially employees in the IT industry, researchers and other international employees educated at higher education institutions (HEIs); HEI students (21%); home-makers (3.6%); and pensioners (2%). Of the User Personas, 14% were unemployed and faced limitations in terms of joining traditional language courses or courses that had fixed study times during the day or evening; 1% were other language learners, and 0.4% were from Pakistan, focusing on the English IELTS exam [23]. Typically, service users prepare for the Finnish National Certificates of Language Proficiency [24] in order to apply for Finnish citizenship. The survey ascertained service users' level of satisfaction with the services offered by the firm, the schedules and the impact of their studies. The firm continually asked for suggestions for developing their services and reacted rapidly to feedback. This paper provides a description and analysis of a realized design that aims to promote international workers' cultural competence (Fig. 1). The study design case presented here was designed entirely online. The key elements were evaluated by using Nielsens' usability heuristics [25] (Tables 1 and 2 in Sect. 4).

4 Results

The key elements of online learning for international workers, identified by UX design and based on the case study in this work, are pedagogical, linguistic, technological and economic accessibility (see Table 1). The key elements identified were utilized and developed further to become increasingly pleasant and effective based on feedback from the service users (Table 2).

Table 1. Identified elements of the Language Gym design and observed advantages and disadvantages when compared to Nielsen's [25] heuristics.

Design accessibility types	Elements identified in feedback relating to the case's design	Advantages → not a problem	Disadvantages → should improve
Pedagogical	Length of the session, non-stop, the joy of learning, empowering, interaction opportunities, customized levels and themes, situation- and simulation-based (actual functionality), the specified method, repeat opportunity, independency, skill-based, quick developments, reactivity, tailored	Designed to meet user expectations and is pleasurable, promoting efficiency, task completion and a positive user experience; provides users with context; minimizes unnecessary complexity and cognitive load; match between system and the real world; user control and freedom	Consistency and standards; aesthetic and minimalist design
Lingual	Comprehensibility, understandable, clear finnish, multilinguality	Clarity; Recognition rather than recall	
Technological	Flexible, scalable, no registrations, fully open accounts, the right timing	Prevents errors; helps users notice, understand and recover from errors; Flexibility and efficiency of use; aesthetic and minimalist design; helps users recognize, diagnose and recover from errors; help and documentation provided	Visibility of system status; help users recognize, diagnose and recover from errors
Economical	Cheap for consumers/customers Possibilities for joint ventures		

Table 2. User Persona groups in the Language Gym design, the feedback collected from service users and how it could be implemented in the design.

User persona group	Sample feedback from users	How feedback could be utilized in the language gym design
Employees in the IT industry, researchers and other international HEI employees, e.g., nursery students, those in the IT industry and researchers, HEI students	Every day, including weekends Evening from 6–10 pm Morning from 8 am–12 pm Lunchtime from 11 am–1 pm 2–3 times a week 15–45 min is a suitable length Flexible; need speaking skills, beneficial; effective; repeat opportunity; good interaction and speaking results; satisfied with learning results; clear web pages; recommendability; language for special purposes	Professional teachers and own methods focused on speaking skills; simulations; non-stop; customized lessons for professions and firms; automation and analytics used to optimize offering; no registration, gym-like participation and users may access an unlimited number of lessons with a monthly card; all classes recorded. customers can always choose a suitable level each day
Homemakers	Before 8 am, Afternoon from 1–5 pm (5%), After 10 pm 3–5 times a week 45–60 min is a suitable length Fun; cheap; difficulties to join with children	Offered daily for 4 levels at different times; multiple channels to follow and for re-study
Pensioners	Afternoon from 1–5 pm 5–7 times a week 60 min or more is a suitable length Fun; cheap; repeat opportunity; expensive	Cost-effective and open solutions that are improved and simplified. learning is made enjoyable, and results can be put into practice at once after class; the joy of learning is kept in focus
Professional persons in other countries focusing on a language exam (Finnish/English)	Good teaching technique; passing the language exam; expensive; technologically easy to join; timing difficulties (e.g., students from China, Finland and the USA in the same session); effectiveness; 100% good results	Offered at different times; culturally accessible technology which only requires a low-speed internet connection (open-access accounts, coaching and real feedback is provided, with high-level exercises targeting the exam

(*continued*)

Table 2. (*continued*)

User persona group	Sample feedback from users	How feedback could be utilized in the language gym design
Professional persons in other countries focusing on developing language skills in working life (Finnish/English)	Easy-to-find information and good design; expensive; good possibility of joining; can improve language skills before starting work/commencing studies in Finland	Skill-based micro-lessons; language and cultural awareness; multilingual approach

5 Discussion

When developing effective online learning designs for international employees and HEI students through UX design, it is important to study the operating environment of user groups and the socioeconomic conditions of learning because if training or services are not technologically, lingually, pedagogically and economically accessible, trainees become frustrated or unable to participate. The results of this study show that effective design of online learning programmes for international employees requires joint planning with users. Co-planning have also been identified as key elements in other studies [3, 19].

In the case of the Language Gym, technological accessibility means ease to use in all situations and with different devices, browsers and screen sizes. As identified in the UX design process, manageable, safe, pleasant, interactive and quick 15-min micro-lessons (e.g., which could be accessed in the workplace at lunchtime) can be delivered via an easy-to-use video conversation [9].

The lingual accessibility of an online learning design means clear, logical, easy-to-absorb and memorable information, and clear information architecture that anticipates potential problems [9]. Pedagogical accessibility is the key element for international service users, as those who come from authoritarian learning cultures often find it difficult to adjust to the Nordic type of pedagogy. The design of a service should take into account participants' prior cultural learning experiences [19].

According to the results of our analysis of the Language Gym, this service should also be empowering and fun. It must produce immediate value, and users must be able to put their learning into practice immediately in the operating environment. In this study, economic accessibility means that the service is cost-effective, and firms can procure it jointly for different occupational groups.

6 Conclusions

The added value of UX-based designs for learning services supporting working people (within the framework of design science research) is that studies can be tailored so that service users get the maximum benefit from their studies. Our study has provided insights

into the world of international employees' daily working life, promoting understanding of how they can and should be supported in this era of increased online learning. The case's design was perceived to be flexible and effective because all accessibility dimensions were fulfilled. Practical and interactive technological design is a viable option, especially for service users who need a way to learn in a busy life. The main limitation of the study is the lack of comprehensive statistical data and analysis in different firms with intercultural employees. It is a good starting point for further studies, and the UX perspective should be considered more systematically in the future.

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Iteration of Children with Attention Deficit Disorder, Impulsivity and Hyperactivity, Cognitive Behavioral Therapy, and Artificial Intelligence

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Abstract. Cognitive Behavioral Therapy (CBT) is a variety of psychoeducational procedures that allow a variety of disturbances including attention deficit disorder, impulsivity, and hyperactivity to be intervened - ADHD to children essentially in school, improving their abilities and integrating into society with better fitness. Cognitive behavioral therapy is based on continuously observing, analyzing, evaluating and evolving; Meanwhile, ADHD is difficult to detect in children under the age of 6 because the symptoms are similar to the behavior of this age, which makes this combination playful, motivating, constant and modifiable in a school group, i.e. a group of children with an average of three years who have no or no disorder through learning through technology such as a robot, toy, computer or any other instrument with artificial intelligence. This iteration has as pillars the game, quantitative observation, discipline, motivation, simulation and creation of solutions, allowing variables, symptoms or causes to be collected automatically from each and the entire school group, instantly analyzed by the robot or tool with artificial intelligence using algorithms or implemented models that systematize what is quantitatively observed to a diagnosis or clinical picture of each and every one of them at that time while continuing the progressive evaluation of each child during iteration with the school group strengthening their qualities, developing their creativity by reducing their anomaly individually. This iteration of child-home-school - artificial intelligence; in the early years of education facilitates the inclusion of each child who suffers from attention deficit disorder, impulsivity, and hyperactivity.

Keywords: Childhood therapies · CBT · ADHD · Therapeutic tools · Learning · Disorders · Behavioral therapy treatments · Inclusion · Education · Robot therapies · Artificial intelligence · Technology

1 Introduction

Attention deficit disorder, impulsivity and hyperactivity, ADHD is a neurobiological anomaly, that is, rebuttals between anatomical and cerebral connections affecting their

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 91–99, 2022.
https://doi.org/10.1007/978-3-030-85540-6_12

behavior such as aggressiveness, carelessness, impatience, generally behavioral problems, mainly in school and being a disorder with symptoms similar to the behavior of infants is not treated in time to unconsciously aggravate is both family and society, consequently exclusion from the child. There are several treatments for ADHD that include therapy and pharmaceuticals, but the drugs have much more side effects in children, so a natural intervention is suggested in child education based on the game instructed by a therapeutic instrument with artificial intelligence, in whose database is cognitive behavioral therapy, CBT, which is coupled with learning theory, appeasing misfit feelings, thoughts and actions, with adaptive skills minimizing and rehabilitating their deficiencies by increasing the quality of life by effect including the infant [1–28].

1.1 Concepts

Attention Deficit Disorder, Impulsivity, and Hyperactivity. Attention deficit disorder, impulsivity, and hyperactivity- ADHD is a neurobiological lack, anatomical and cerebral communication are confused causing skills not appropriate to the environment, hindering family, school, and collective interaction. This disorder is genetic and environmental, it can be born with ADHD by inheriting in 76% of parents with ADHD or 50% of parents and/or family members who suffer from any disorder or develop at any stage of our lives due to being premature, precarious conditions at birth, a conflicting family environment, accidents with neural injuries, cranioencephalic, nervous system infections, malnutrition, use of toxic substances, environmental pollution, among others. Symptoms of ADHD in an infant are confused with the actions of the first few years of life such as restlessness, tantrums, disobedience, attention-getting, having no control over their actions, not thinking about the consequences or the danger of their impulsivity, etc. so parents or adults who are in the care of the infant by not knowing about this disorder increase their aggressiveness, impatience or their carelessness in not providing adequate and on time therapy or treatment [1–6, 10–19, 23–26, 28, 29].

Cognitive Behavioral Therapy. CBT is a multiple set of techniques, heterogeneous psychological that treats a wide range of disorders that can affect a person, especially children developing their skills, decreasing bad behaviors, and improving their minds. This therapy defines "what you think can determine how you feel," analyzing the situation based on your feelings—thoughts and misconduct. Infant CBT is "here and now" identifies negative anomalies or thoughts through play or playful activities, observing their body language and listening to the game's narrative and with the help of an artificial intelligence tool instantly applies cognitive behavioral restructuring, psychoeducation by tabulating their symptoms and simulating various solutions for the child to learn the alternatives and consequences and incentivize to create solutions [7–9, 12, 13, 15, 17, 20–22, 27, 30, 31].

Artificial intelligence is a set of techniques implemented to an instrument or tool capable of collecting, analyzing, and solving problems, this therapeutic tool in learning should have in its database the goal of cognitive behavioral therapy as well as the progressive evolution of the child, know the psychoeducational status of the child, he should consult, diagnose, collect information in the field based on games, drawings, stories, incomplete

phrases and empathetic questions and finally train through psycho education simulating several solutions that develop their cognitive behavioral abilities to face daily problems, that is, this therapeutic tool applied in the education of children facilitates an integrative school to be "an inclusive school in which students with special needs or without them can: learn to know, learn to be, learn to live together and learn to do". The learning tool can be implemented in a caricatured robot, therapeutic toy or on a computer that uses systematic observation, hypothesis formulation, hypothesis checking through covariation between causal variables and individual fact tabulation to the school group, from an intensive study of the moment "here and now". It breaks down problems into small parts by specifying their link and consequence for example these parts can be emotions, thoughts, physical sensations, economic situation, biological, genetic, environmental, among others, breaks negative behavior and changes the cognitive behavioral thought-action-feeling helping to face for itself problems with another vision through psychoeducation that simulate E-R stimulation-response for social learning and finally demonstration of hypotheses with facts, designing the individual model to explain group that allows to apply to everyone without distinction [7–9, 12, 13, 17, 27, 30, 32–34].

2 Cognitive Behavioral Therapy Steps

For the development of each and every step of cognitive behavioral therapy is with the iteration of the child, family and adults to care for the child, school, therapist and therapeutic tool [7–9, 12, 13, 15, 17, 21, 22, 27, 30, 35–38].

Gathering information (see Table 1) using:

- Interviews: includes n the entire patient story in all areas, in case of silent children, information is obtained by comics, incomplete phrases, graphics and/or personal games or through technology or artificial intelligence for example video games and Structured interviews to adolescent, family and school for example clinical interviews such as K-SADS, deficiency inventory: childhood depression – CDI, phobias, daily stress-IECI, personality questionnaire - EPQJ, child behavior inventory -CBCL, anxiety and depression- CECAD; Ackenbach behavioral checklist, SCAReD, Barkley and Murphy's scale of distraction and impulsivity activity, multifactor adaptive self-assessment test - TAMAI, among others.
- Self-rules and standardized instruments such as psychometric, physiological evaluation tools, computer testing- assessment of the ability to pay sustained attention through a computer, continuous execution tests and attention variables- response to auditory or visual stimuli agrees to the attention it pays when pressing a computer key, among others. Triple column self-rules are the most commonly used, which can be filled automatically by quantitative observation of the robot or therapeutic toy.
- Behavioral observation: appearance, postural, gestural and verbal action of the child; the therapist qualitatively evaluates while performing a quantitative, constant and evolutionary observation by the learning tool with artificial intelligence, that is, the robot, toy or therapeutic tool when observing each and the whole group performs an individual and group behavior assessment both at school and as a family because its behavior can be different at school and at home or sometimes the combination of this.
- Obtain a primarily clinical history of family members, education, events, data on people significant to the patient and their consequences [1–9, 12, 13, 17, 21, 27]

Table 1. Causes and consequences of ADHD.

Causes	Consequences
Family factors	**Family area**
Genetic: 76% of parents with ADHD inherit brain function and have a 50% chance when a family member has a cognitive disorder	They talk non-stop, interrupt any activity
Parents or family members with autism	They are noisy, they disobey
Age of parents, number of siblings: first or last death of a relative	They don't stay alone; they want to be the center of attention
Non-family factors	High levels of stress at home
Adoption: The adopted child may have suffered from problems at birth or his mother suffered from malnutrition or was exposed to toxic substances during pregnancy	Continued sibling fights, consequence of parent discussion Divorces
Environmental toxins are all chemicals that could be absorbed by the fetus or at the time of birth via smell, taste, touch or sight, affecting the development of your body, brain and/or nervous system	Feeling careless, abandoned and loneli Child Depression Low self-esteem
Smoking and/or alcoholism, stress when conceiving or during pregnancy. Consumption of dyes, preservatives, energizers, or other food additives	Misunderstood brothers, lack of trust, inclination to additions, crime
Live in an industrial sector, high levels of lead from pipes or paint and/or environmental pollution	Reduced social life Community problems Family isolation
Other factors	**At school**
Fetal development: bumps or accidents during pregnancy, or time of delivery due to lack of prenatal care	Low performance due to in a lack of attention, absent in classes and/or over-restlessness
Low weight Prematurity	Not passing exams for responding impulsively
Baby's position and existence of fetal suffering	He suffers aggression and/or fights with his peers
Brain skull trauma	They don't respect rules, nor do the ranks
Glucose and toxin in the blood causing brain injuries such as mental retardation, ADHD, learning disorder	They occupy special places in class, so they don't disturb their classmates and interrupt class
Having suffered cerebral palsy	They are excluded by other children
Stroke	Punished by teachers until expelled

By establishing an initial infant level, the therapeutic tool sets the test in progress and diagnoses with several specialists (minimum a psychiatrist, clinical psychologist, neurologist, general physician, among others), family and school and begins [7–9, 12, 15, 17, 21, 30, 39] to:

- Correlate causal hypotheses in ascending and descending form structurally.
- Individual clinical pictures which can be an analysis of: triple frequency-intensity-duration contingency ratio and environmental events generating behavioral prediction; Multiple physiological-autonomous, cognitive-verbal, motor-behavioral response systems; Behavioral analytical formulation: situation-mind- emotion-environment-behavior; Clinical formulation with behavioral evaluation: thought-feeling- evolution of falseness to an adaptive or.
- Combination of diagnosis by performing an array with the summary of variables for each subject, covariations found, and responses made.
- It establishes the relationship of the different levels of the individual diagnosis, projects causal hypotheses for the molar or collective formulation.
- It programs mechanisms and constantly modifies any intervention according to the child's need for the school group, the same one that will evolve according to its influence of each and every infant.

Below are the types of ADHD that are currently identified, the most common symptoms of each of the types of ADHD, and some treatments that include techniques and tests that are applied in cognitive behavioral therapy - CBT for children with ADHD (see Table 2) [1–9, 12, 13, 17, 21, 27, 30, 35–37, 40, 41].

Table 2. Types, symptoms, and treatment for children with ADHD

Types of ADHD	ADHD symptoms	Treatment for children with ADHD	
		CBT techniques	Examinations and pharmacos
ADHD with hyperactivity and impulsivity	Excessive energy movement, exasperating attitude; interrupts any activity and everyone, noisy does not respect shifts, restless	Systematic desensitization, Stress inoculation, Behavioral modification operatives, Self-control techniques, Relaxation and breathing techniques	Ritalin- tranquilizer Methylphenidate for over 6 years
ADHD with inadog	He lives in his world Frequent boredom It doesn't end any action, it makes mistakes, bad memory, carefree, it gets easily distracted	Social learning technique, speech and language technique, modeling, Self-instruction training, physical activities such as: dance, dance, rhythmic and artistic exercises	Electroencephalogram exam Assessment of the senses Hearing, visual exam

(*continued*)

Table 2. (*continued*)

Types of ADHD	ADHD symptoms	Treatment for children with ADHD	
		CBT techniques	Examinations and pharmacos
Mixed or combined ADHD	Suddenly shifts from restlessness to immobility, constantly fighting, mental health in danger, impatient, evasive, impetuous, aggressive, excessive movement	Problem-solving training Behavior change operatives, social learning technique, self-control techniques, yoga, stop, think and act games	Psychiatric examination Graphological assessment-personality scale Caffeine, nicotine
ADHD with executive functioning difficulty	ASD, Down S., dyslexia, dysgraphia, dyscalculia, eating disorder, sleep disorder, fears and phobias, self-esteem, habit reversal, mood disorder, anxiety and depression, defiant negativist disorder, etc.	Social learning technique, speech and language technique, modeling, up arrow, cognitive restructuring cognitive contingencies, Exposure techniques	Physical and mental examination Electroencephalogram Examination of all the senses, psychological examination Caffeine, nicotine Diets

In conclusion, cognitive behavioral therapy for children with ADHD and an artificial intelligence tool complies with collecting through quantitative observation, analyzing through information gathering through playful activities, diagnosing by correlating variables such as symptoms, genetic and socio-environmental causes, consequences, feelings, thoughts, beliefs, situation, among other difficulties in finally simulating possible scenarios or psycho-educating actions by educating infants to solve problems, look for options, maintain control and create alternatives, so that children with ADHD when psycho-educating them are cognitively restructured and unconsciously will follow schedules for minimum action from getting up to bed, will be organized, will respect rules, perform tasks creatively both at home and at school and at the end of the day will receive praise, motivate them and improve their interactions day by day.

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Pros and Cons of Vaccine Program in Indonesia (Social Media Analysis on Twitter)

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Abstract. This study looks for the relationship between social media and the sentiment in COVID-19 vaccine policy in Indonesia spread on Twitter. This study used social media data from Twitter with hashtags related to vaccination program issues. This study used Nvivo 12 to collect data and analyze data with word cloud analysis, matrix analysis, and crosstab analysis. The results showed that the government used Twitter to convey information about the COVID-19 vaccine by 100% pros. The pro-cons opinion mapping on the news is 37.5% for the pro opinion and 62.5% for the cons opinion. The general public opinion showed 21.32% for pro opinions and 77.68% for contra opinions. This study's limitations were only hashtags and pros and cons.

Keywords: COVID-19 · Sentiment analysis · Vaccine policy · Government · Opinion

1 Introduction

COVID-19 is a new coronavirus strain. Corona is represented by the letter CO, virus by the letter VI, and disease by the letter D. This disease was previously known as the '2019 novel coronavirus,' or '2019-nCoV.' The COVID-19 virus is a novel virus that belongs to the same virus family as Severe Acute Respiratory Syndrome (SARS) and some common colds [1]. Since the discovery, many world community records have changed, including in Indonesia. The government announced the first case of coronavirus infection in Indonesia on March 2, 2020 [2]. Wednesday (3/3/2021), around one year, the coronavirus outbreak that causes COVID-19 has been confirmed in the country, and more than 1.34 million confirmed cases have happened. Many confirmed cases in Indonesia make a big job for the government as the country's spearhead. The government has issued many policies during the COVID-19 emergency from 2020.

One of the policies that are still widely discussed is the issue of providing the COVID-19 vaccine following the Regulation of the Minister of the Republic of Indonesia, Number 84 of 2020, regarding the Implementation of Vaccinations in the Control of 2019 Corona

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 100–107, 2022.
https://doi.org/10.1007/978-3-030-85540-6_13

Virus Disease Pandemic (COVID-19). Since this policy was issued, many public arguments have roamed, especially on social media. Some people think that this vaccine is a solution. Some think this vaccine is not clear about its effectiveness and safety.

The Ministry of Health has explained the type of COVID-19 vaccine as determined by developments in science and technology and listed by the World Health Organization (WHO) [3]. The most accessible media to see how the pros and cons of opinions circulating in society are by looking at social media platforms. In this research, the researchers will use data sources from social media Twitter. Though Twitter does not generally represent the general public's views, it does reflect the types of news that people are exposed to and is a significant source of vaccine opposition and misinformation [3].

Research on the pros and cons of vaccine policies worldwide based on Twitter has not been widely carried out, especially in Indonesia. Sentiment analysis is a branch of text mining research that seeks to evaluate the public's (audience's) interpretation or subjectivity on a topic of debate, event, or issue. Sentiment analysis is a classification task that determines whether a text is positive or negative [4]. This paper seeks to answer the following questions:

Q1: What are the functions and links between social media and vaccine policy in Indonesia?
Q2: What are the opinions spread on media social regarding vaccine policy in Indonesia?

2 Literature Review

2.1 Twitter for Opinion Mining

Social media allows the public to give their opinion. Twitter, in particular, is one popular social media platform, where the users share their views from music to movies to politics and other hot topics [5]. Indonesia covers more than 52% of the total social media users globally [4]. Twitter is one example of the most concise and precise microblogging sites to create models for identifying "tweets" into positive, negative, and neutral sentiment. People often use a "hashtag" to tweet about current affairs, which is frequently the primary subject of inquiry [6].

This study uses hashtags as its main tool. Hashtags are a community-driven convention for applying meaning and metadata to tweets on Twitter. They are used by Twitter users to categorize tweets and highlight subjects by simply prefixing a word or expression with a hash mark, such as "#hashtag." People find Twitter more vocal and friendly because of its extensive use of hashtags [7]. Go et al. published one of the first studies in this area, in which the authors tried a novel approach to identify sentiments in tweets automatically [8, 9]. One downside of this method is that this testing data is gathered via Twitter search queries, biased. POS (Parts of speech) tags are also used as features in the analysis [8, 9].

Text mining from Twitter is divided into three stages: text pre-processing, feature selection, and text analytics. Tokenizing, filtering, stemming, marking, and evaluating are some of the phases of text pre-processing. The stop list algorithm will filter out words, including pronouns, adverbs, conjunctions, prepositions, and clothing. The word list algorithm, on the other hand, will save essential words [10]. In general, most of the

research using the Twitter database states that Twitter is an exciting data provider and can describe a bit of the emotional state and public opinion. However, the spread of misinformation and unverifiable information are significant Twitter limitations, especially in non-academic contexts and users [11].

2.2 The Spread of Opinion on the COVID-19 Period Based on Twitter

Twitter has amassed a sizable following all over the globe [13]. There have been heated discussions about the effect of Twitter on accessing health information or the dissemination of false information [14]. One result is the public's social distancing viewpoints revealed through sentiment, emotion, and content analysis of tweets [15] or COVID-19 causes men to die at a higher rate than women [16].

One study aims to identify the most frequently occurring words, categorize every opinion that appears into the categories of neutral, positive and negative sentiments, and know influential Twitter accounts related to COVID-19 [12]. The methods used were Wordcloud Analysis, Sentiment Analysis, and Social Network Analysis. The results of word cloud analysis showed the words that appeared regarding COVID-19 were "positive", "pandemic", and "Indonesia." [12]. The average mood was positive for ten topics, while for two topics, it was negative (deaths caused by COVID-19 and increased racism). The average number of tweet topics per account follower ranged from 2722 (increased racism) to 13,413 (increased racism) (economic losses) [13].

3 Method

This research was conducted to focus on social media Twitter's role in analyzing sentiment during the issuance of the COVID-19 vaccine policy. One of the data sources for this research was international articles, and data organizing is done by searching through a database (http://www.googlescholar/.com). Researchers' primary data source was the hashtags on Twitter related to pros and cons opinion in society.

Sentiment analysis is a branch of text mining research that seeks to evaluate the public (audience) interpretation or subjectivity of a topic of debate, event or issue. Sentiment analysis is a classification task that determines whether a positive or negative test. After related hashtags collected and mapped through NVivo 12, this study used three different analyses: analysis of crosstab analysis, cluster analysis, and word cloud analysis. Nvivo 12 Plus was used as a tool to analyze data and collect data from social media. Social media data was relevant for users to see the pros and cons of vaccines trending on social media. This study used five hashtags (Table 1).

Hashtag material was downloaded using the Nvivo 12 plus N-capture program. After all data preparation has been done, the authors translated the data into three types. There was a matrix coding query to see the percentage of nodes (classification) pros and cons with the five hashtags above. The second was the crosstab query which would look at the relationship between pro and con nodes (classification) with the most hashtags used, and the last one was word cloud to see which the most frequently used words and most influential as long as sentiment towards vaccine policy circulates in society.

Table 1. Hashtag trending on social media

#refusevaccine	This hashtag is used to see the opinion against vaccines
#refusesinsinovacvaccine	This hashtag is used to see the opinion against vaccines
#vaccineforus	This hashtag is used to see the pro opinion on vaccines
#vaccineforindonesia	This hashtag is used to see the pro opinion on vaccines
# vaccinesfordomesticrecovery	This hashtag is used to see the pro opinion on vaccines

4 Result and Discussion

4.1 The Opinion Spread on Media Social About Vaccine Program in Indonesia

In this research, Twitter has significantly contributed to the circulation of sentiments in society. To see it more logically and based on existing data, the researchers would process five hashtags representing the pros and cons in society in this research. The researchers successfully inputted five hashtags. They were #refusesynovacvaccine, #refusevaccine, #vaccinesfordomesticrecovery, #vaccineforindonesia and #vaccineforus. After determining these five hashtags as opinion mining, the authors then determined the nodes that became the indicators or classification of the opinion of hashtags. This research is a sentiment analysis that requires data processing to provide a classification value to the data source. The researchers used two nodes. The first node was for the pros and the second node was for the cons. Next, to look at the actors who played a role in distributing this hashtag, the researchers determined cases with three main actors: government accounts, community accounts, and news accounts.

After all data preparation had been done, the researchers translated the data into three analyses: word cloud, matrix coding query, and crosstab query. The result by Nvivo 12 to word cloud is shown in Fig. 1 below.



Fig. 1. The most frequently occurring words in the five hashtags

A word cloud aims to see which terms are most often used and prominent in society as long as public opinion on vaccination policy exists. Most is a vaccine for domestic

vaccination from this word cloud and shows the dominant opinion five this hashtag. Many reject COVID-19 vaccines and leave the Sinovac vaccine, which is the opposite word from the words obtained for the first time. Two opinions circulate in society even though the comparison of the pro and con opinions looks a little contrasting. The word pro is much bigger and more dominant, but words scattered on Twitter show rejection of this vaccine policy.

Then on this word cloud, the word government and society there are found. These two actors are the most affected by hashtags—the government as a policymaker and an articulation for the vaccine policy itself. With the introduction of a COVID-19 vaccine, there is a good chance of putting an end to the pandemic that has wreaked havoc on people's lives [14]. Promotion and motivation, on the other hand, are based on public confidence. The government's strategic communication efforts to create public confidence are crucial in promoting COVID-19 vaccination to reduce society's cons.

4.2 Pro and Cons Vaccine Program in Indonesia

After we determine the spread of the most popular words on Twitter about vaccine covid-19, next is a matrix coding query to see the percentage of nodes (classification) pros and cons with the five hashtags below (Fig. 2):

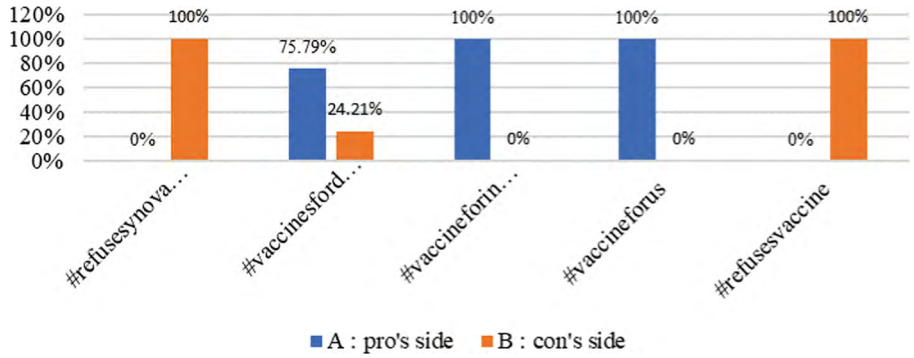


Fig. 2. The percentage of pros and cons is seen from the five hashtags.

The matrix coding query mapping looks at the percentage of nodes (classification) pros and cons with hashtags. From the mapping above, #refusesynovacvaccine and #refusevaccine, the distribution of opposing opinions is 100%, then for the hashtag #vaccinesfordomesticrecovery, distribution of counter opinions is 24.21% while the pro opinion is 75.79%. The hashtags #vaccineforindoensia and #vaccineforus get 100% pro opinion distribution. The data shows two contrasting ideas circulating in the community so that the acquisition percent majority will be dominant in their respective existing classification, seen from the acquisition of 4 hashtags with 100% in one of the nodes. However, one hashtag represents a mixture of 2 opinions in one hashtag, namely #vaccinesfordomesticrecovery, with 75.79 for pro nodes and 25.21 for cons nodes. Even though the dominant nodes still exist, some accounts use this hashtag as sarcasm and

are pressured against the existence of a vaccine policy even though the general picture of this hashtag is pro to vaccine policy.

After the distribution of the opinion, the pros and cons of the hashtag are shown. The actor who plays a role in the circulation opinion of pros and cons is revealed in the coding crosstab query chart below (Fig. 3).

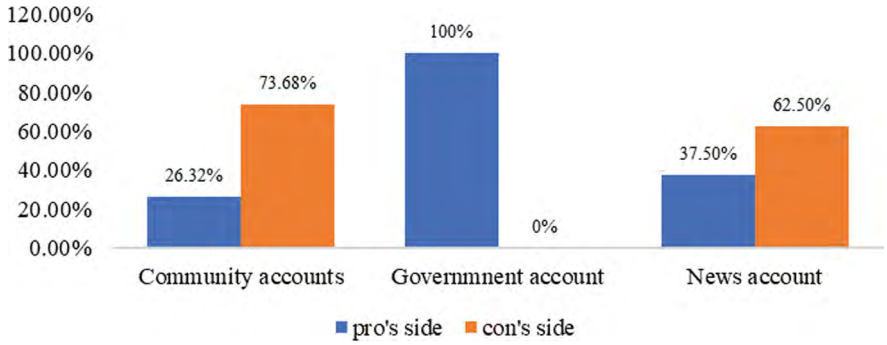


Fig. 3. The Percentage of pros and cons according to the most influential role

In this crosstab query analysis, the percentage of the spread of pro and contra sentiments seen from the accounts of the actors who provide opinions or information is obtained. The first account is the government account. The government gets a percentage of 100% for pro opinions and 0% for contra opinions from the results above. Most government accounts that have successfully written manually coding are primarily from the Indonesian health ministry accounts, which aggressively promote vaccines' safety and importance for the community. Other government accounts are also available to disseminate opinions even to the local government Twitter accounts, such as accounts BPS Bojonegoro Regency. Obtaining maximum pro opinions and 0% for contra opinions is essential for the government to spearhead vaccination policies in Indonesia. More community engagement and better government messaging to educate and persuade people about the value and protection of going to primary care for vaccines during the pandemic is necessary [15].

The second account is the news account. The pro and con statements as introductory statements in this type of charge because almost all news deliveries only discuss topics currently updated in the community cannot be directly be interpreted. Most of them collect existing opinions, either from competent statements or from the public. Their work entails "testing a story out" for validity, which can take months of analysis or only a few minutes of introspection or consultation with a colleague [16]. The pro-cons opinion mapping on I news is 37,5% for the pro opinion and 62,5% for the cons opinion. Many news stories discuss public unrest related to vaccination policies, but not a few news accounts share information about the importance of vaccines, which input brands from the opinions of a state official.

The final dissemination of opinion is from community accounts. Community accounts will mainly express opinions privately as a citizen. The proposed method identifies sentiment in tweets by extracting opinion words (a mixture of adjectives, verbs,

and adverbs), assessing emotions in adjectives using a corpus-based methodology, and analyzing semantic scores verbs-adverbs to find the emotion values of the opinion words [17]. By reading the scattered tweets one by one, the researchers can categorize the general public opinion into 21.32% for pro opinions and 77.68% for contra opinions. The large percentage of contra in society can be caused by opinions that question the law of consuming vaccines in religion, considering that the ingredients used in these vaccines are not necessarily halal. The safety of vaccines and the side effects produced from vaccines is also a common fear for the community, especially since there are many deaths after people receive the vaccine. Besides, the issue of the availability of vaccines for the public was also a topic discussed at the beginning of the emergence of this program. Many people say that procuring vaccines is only part of a government-run business. Transparency allows for more preventative measures and foresight to develop a more defensive strategy in the battle against the unknown enemy [18].

5 Conclusion

The results showed that the government used Twitter to convey information about the COVID-19 vaccine by 100% pros and 0% for cons opinion. While opinion mapping on the news by collect existing opinions, either from competent statements or from the public are 37,5% for the pro opinion and 62,5% for the cons and. The last, general public opinion showed 21.32% for pro opinions and 77.68% for contra opinions. Updating and adding information is still needed, especially for academics who can sharpen the scope of discussion regarding Twitter's role in disseminating information and express opinions during this pandemic because this study only focused on five hashtags.

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Cyber Risks in Maritime Industry – Case Study of Croatian Seafarers

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Abstract. Cyber-attacks have become a problem at a global level. Awareness of cyber threats has grown in recent years, driven by companies' growing dependence on data and information systems and a series of major incidents. Maritime transport is the most represented branch of transport in the world and is highly exposed to cyber-attacks due to sophisticated equipment and high usage of information and communication technology. The aim of this research is to examine awareness of Croatian seafarers about cyber threats using a questionnaire. The results of the research show that there is a high level of awareness of cyber threats. However, without a serious full integration of technical and human factors and educated, trained and aware staff, there is no reliable security system, or a system that can withstand security challenges.

Keywords: Cyber-attacks · Seafarers · Challenges · Questionnaire

1 Introduction

Ships and their systems use advance technology which is highly dependent on information and communication technologies. They use them on daily basis for exchange of information, for safe operations of vessels and for conducting business. Therefore, ships and consequently companies are more and more exposed to growing number of cyber threats and cyber-attacks. Companies should raise awareness of their employees - on vessels and on shore on potential cyber risks and on the importance of cyber risk management and mitigation.

The usage of advanced technology has brought many changes in maritime sector. Over the last decade, maritime industry has been exposed to more cyber threats and attacks than ever before. It is not possible to determine the exact number of attacks, as in many cases the attacks pass unnoticed or are not reported. However, all stakeholders in the industry have proven to be vulnerable: ports, ships, maritime authorities, offshore drilling units, shipping companies, etc.

The port of Antwerp [7] was a victim of cyber-attacks for more than two years. A malware enabled the hackers to control the movement and location of containers, and to consequently steal the cargo. The malware was sent via an employee's e-mail.

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 108–113, 2022.
https://doi.org/10.1007/978-3-030-85540-6_14

Several ships were highjacked with a help form a key log malware. Somali pirates [6] were hacking information on location, crew cargo and itinerary of the vessels to extort ransom form various ship owners.

An e-mail containing a virus in the attachment shut down the entire IT system of the Danish Maritime and Business Growth Ministry for a few days. The data on Danish shipping companies and merchant navy were compromised [8].

An offshore drilling unit in the Gulf of Mexico [9] drifted away, and brought the crew and the unit in danger, because of a malware virus which disabled the signals of a dynamic positioning system.

The biggest shipping company in the world Maersk [10] suffered an attack of a NotPetya ransomware which infected all devices and all business units in the company. The company was not able to use the IT system for ten days and the entire IT infrastructure had to be reinstalled.

The aim of this paper is to examine the awareness of Croatian seafarers on cyber risks, cyber threats, their personal responsibility regarding the usage of IT equipment and knowledge of cyber risk management.

2 Cyber Risk Management

Cyber risk management is a relatively new segment of maritime industry. Maritime industry has been dealing with challenges related to cyber security for over a decade. Several leading (maritime) organizations such as International Maritime Organization (IMO), International Chamber of Shipping, BIMCO, World Shipping Council, the European Parliament, International Organization for Standardization (ISO) have developed a set of guidelines on maritime risk management: IMO MSC-FAL.1/Circ.3, Guidelines on maritime cyber risk management (IMO, 2017), Resolution MSC.428(98) - Maritime Cyber Risk Management in Safety Management Systems (Maritime Safety Committee, 2017), ISO 27032:2012 (International Organization for Standardization, 2012), EU Regulation 2016/679 (The European parliament and the Council of the European Union, 2016), BIMCO Guidelines on Cyber Security On board Ships (BIMCO, 2017), etc.

According to the previous experience and current knowledge, maritime industry in not completely prepared for dealing with cyber risks. The European Union Agency for Cybersecurity, ENISA in its *Guidelines for cybersecurity in maritime sector* provides a four-phase approach to cyber risk management:

1. identifying cyber-related assets and services – IT technologies used on board and on shore which are dependent on the Internet (AIS, ECIDS, GPS, GNSS)
2. identifying and evaluating cyber-related risks – sensitive and critical data, cargo, people, financial loss, frauds, system damages, reputation, environmental disaster, shutdown of operations
3. identifying security measures – data classification, asset inventory, asset monitoring, privacy and compliance issues, crisis management, cybersecurity training
4. assessing cybersecurity maturity – developing cybersecurity programs, organizing educational workshops, forming cybersecurity team, asking external resources for advice [4].

What should maritime companies and organizations do?
Here are some of the preventive measures that companies should adopt:

1. raise awareness on cyber-attack issues at the executive level
2. adopt good "cyber hygiene" to deter attacks
3. prevent accidental security compromises, develop, and implement appropriate IT policies and maintain top-down approach
4. backup data regularly
5. maintain strong users access controls
6. set up strong network access controls
7. constantly update all software programs
8. train employees to recognize cyber-attacks and seek immediate support to prevent losses
9. develop strong policies regarding external storage of data, such as a USB memory stick and other external drivers [5].

It is clear from all previously mentioned that a proactive strategy for cyber risk management is important, especially in industries such as maritime industry, in order for maritime companies to protect their infrastructure and ensure market viability [11].

3 Results and Discussion of Quantitative Research on the Example of Seafarers Attending Special Education Program

This chapter presents the results of the quantitative research carried out among the seafarers who attend the Special Education Program at the Faculty of Maritime Studies Split, University of Split. The SEP, as a part of lifelong learning, enables seafarers to acquire the highest marine engineer's qualifications in accordance with STCW Convention [1]. A questionnaire was created to conduct research on the awareness of Croatian seafarers about cyber threats. It consisted of 22 questions which were partly adopted from [2] and [3], and some additional questions were added. The questions were divided into 5 categories. The categories, except for the first category on personal information, correspond with the topics and the content to the cyber risk management phases from *Guidelines for cybersecurity in maritime sector* mentioned in the previous paragraph.

The questions were related to the following topics:

1. Personal information: age, number of years in service, type of company (vessel) and nationality
2. Industry: dependence on IT technology, ship based cyber area (AIS, ECIDS, GPS, GNSS), people
3. Cyber related risks: e-mails, web sites, crew, social engineering, Wi-Fi network
4. Security protocols: knowledge and the role of crew, factors influencing maintenance and update of electronic devices, login details, account details
5. Assessment of cybersecurity maturity: signs of cyber-attacks, identification of cyber-attacks

The research was conducted in February 2021. The questionnaire was distributed to 60 seafarers attending the Special Education Program (SEP) at the Faculty of Maritime Studies Split, University of Split. They were included in this research as they have already a substantial work experience and are therefore acquainted and familiar with cyber threats and risks. Out of 60 distributed questionnaires, 10 were excluded from this research as they were not entirely completed.

The seafarers between the ages of 18 and 59 were included in this research. The majority (52%) of survey respondents are between 30 and 39 years, 34% are between 40 and 49 years, 10% are from 18 to 29 years old, and 4% are between 50 and 59 years old. It is also interesting to note that the majority of respondents sail on cargo ships (62%) and even 92% of them sail on foreign companies. Given that 50% of the seafarers who completed the survey sailed from 3 to 5 years, and that 32% of them sailed between 10 and 15 years, the sample is considered to be well chosen due to the experience the surveyed gained on board.

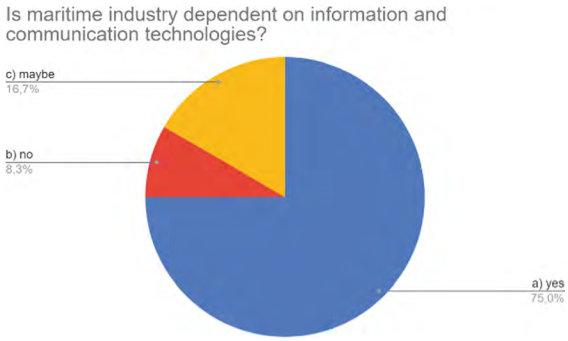


Fig. 1. Dependence of the maritime industry on information and communication technologies

As illustrated in Fig. 1, dependence of the maritime industry on information and communication technologies has already been proven in some previous research [2, 3], therefore it is not surprising that 75% of the respondents consider the maritime industry to be highly dependent on and communication technologies, and only 8% hold the opinion that the dependance of the industry in not too excessive.

The seafarers were asked to what extent are ship master and system operators able to identify errors in the data they receive and whether are able to check accuracy of received data. 74% of the respondents believe that the ship master and system operators can identify 50% of the errors in the data they receive and that they are able to examine the accuracy of received data. Only 2% hold the opinion that it is not possible to identify errors in received data.

Consistent with the previous response, 50% of seafarers believe that the ship's crew are able to understand and to adhere to security protocols for transmission of data over the Internet.

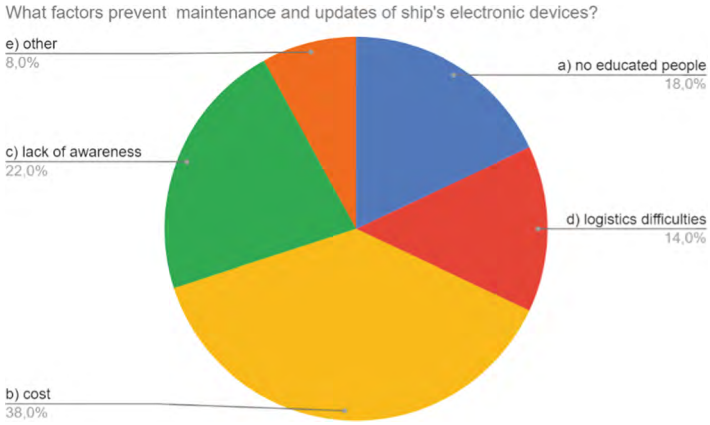


Fig. 2. Factors preventing maintenance and updating of ship's electronic devices.

It is evident from Fig. 2 that 19 seafarers (38%) think that cost is a factor that affects maintenance and updating of ship's electronic devices. 22% believe that there is a lack of awareness, while 18% feel that there are no educated people and 14% consider logistic difficulties to be prevailing problem for maintenance and update of ship's electronic devices. As expected, cost prevailed in these responses due to the cost of individual system components (Fig. 3).

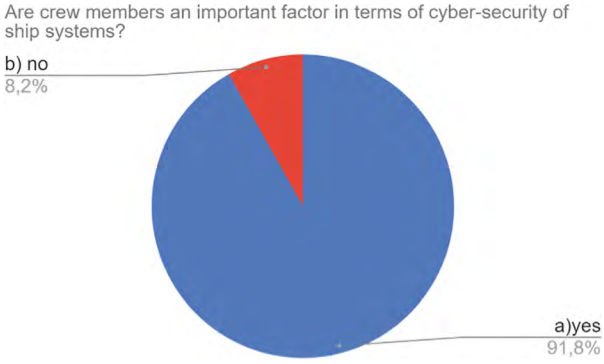


Fig. 3. Crew members are important factor in terms of cyber-security of ship systems.

Most seafarers hold the opinion that crew members are an important factor in terms of cyber-security of ship systems.

4 Conclusion

Due to the expansion of unavoidable information and communication technology, maritime industry is becoming increasingly dependent on those technologies. This paper

aimed to assess the awareness of Croatian seafarers about cyber risks and cyber threats. The results of quantitative research show that Croatian seafarers are highly aware of the dangers that are hidden in cyber threats, but also hold the opinion that costs are a problematic variable in terms of cybersecurity of ship systems. They also believe that the human factor is an important factor in identifying cyber problems. However, it is worrying that 78% of surveyed Croatian seafarers believe that cyber-incidents pass unnoticed over a long period of time and that visible system failures are nor recognized nor reported by alarming ransomware messages. This answer is a confirmation of previously conducted research and serves as a proof that the occurrence of threats in cyberspace is still high.

It can be concluded that even though that there is a high level of awareness of cyber threats, there is still a long way to go to a safe and secure digital environment. This is mainly due to the weakening of existing cybersecurity measures which are caused by changes in working and infrastructure pattern. The authors believe that further research should be directed towards finding new methods of elimination of cybersecurity as well as better training of seafarers in terms of cybersecurity.

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Social Challenges to Communication in Digital Environment

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Abstract. During the global anti-epidemiological measures imposed to combat the COVID-19, in July 2020 protests broke out in Bulgaria, caused by a number of corruption scandals in the country. The demand was the resignations of the chief prosecutor of the Republic of Bulgaria and the ruling government and sumonning of early elections for national Parliament. The object of the study is the public unrest against corruption in Bulgaria. The subject is the relationship between digital and real environment through computerization. The research method is analysis. Some of the conclusions are that the protests in Bulgaria ran from the virtual to the real environment and back through social networks and social media and had significant societal impacts.

Keywords: Communication · Digital society · Virtual protests · Real protests

1 Introduction

The COVID-19 pandemic has completely changed the rhythm of life all over the world. The anti-epidemiological measures imposed to combat the virus, such as social distance, and the consequences of the global lock down, such as rising unemployment, are only a small part of the negatives affecting people during this period of social and economic challenges. In the context of global insecurity in spheres such as healthcare, economy, social live, politics, etc. in July 2020 protests broke out in Bulgaria, caused by a number of corruption scandals in the country. The accumulated negative public energy pointed out at the Bulgarian ruling party with the request for resignations of the chief prosecutor of the Republic of Bulgaria and the Government led by the center-right political party *Citizens for European Development of Bulgaria* (*CEDB*).

The purpose of this study is to trace the different points of view, the attitudes and the culture of communication of the various representatives of society, the government and the media in relation to public and political discontent in the country.

The Bulgarian President supported the protests and called for fair early elections for a new Government. In his appeal to the protesters in the square, the President also called for "Mafia, get out!", which was raised by the discontents and became one of the slogans of the protest.

It is no coincidence that according to the Bulgarian culturologist Georgi Lozanov, these protests were not so much political as cultural [1]. According to him, the social dissatisfaction was addressed along the main conflict of the transition – between the

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 114–121, 2022.
https://doi.org/10.1007/978-3-030-85540-6_15

former communists and the democratic expectations of the post-communist society. It can be said that the protest was against the underground environment, which has not only become something normal for the Bulgarian society, but also a face of success in it [2].

Another part of the protesters' demands included remote voting, convening a Grand National Assembly and reforming of the Bulgarian Constitution, lustration of former communists in power, modernization of the administration, removal of people from the mafia as a privileged stratum, defending freedom of speech, etc. There were also demands for criminal prosecution of this part of the government, which was guilty of corruption in the country. A special focus of these protests was the demands for changes in judicial reform. The goal of the protesters was a future government and judiciary in which the oligarch Delyan Peevski and the honorary chairman of the political party Movement for Rights and Freedoms - Ahmed Dogan will not have a decisive role behind the scenes. According to some analysts, the two effectively controlled the country's governance for many years.

The motivation of the non-protesters to state their disagreement with the mass public discontent was related to their skepticism about the ability of any alternative to the ruling political party to change the status quo in the system. They did not believe that Government will improve the situation in the country, but even less did they believe that a positive change would take place if another party took the power. According to them, the problem is deeply rooted in the corrupt system and superficial political castling would not significantly change the situation. One of their criticisms of the protesters was that they do not have clear goals and cannot nominate a charismatic person as a leader to unite the nation. The "poisonous trio", as the journalist and public figure Arman Babikyan, the sculptor Prof. Velislav Minekov and the lawyer Nikolay Hadjigenov were nicknamed, who at some point became protests' leaders and organizers, did not provoke positive associations and failed to ignite ideas and clear targets to the nation, said critics of the protest. According to them, the very negative connotation in their name did not suit public unifiers. Non-protesters also expressed other concerns that gathering of many people in one place would become a source of infection of COVID-19. Opponents of the protest believed that the blocking of key intersections, such as the Sofia Eagle Bridge, the space in front of the presidency, etc., hindered the normal functioning of the urban environment.

By not participating in the protests, the non-protesters clearly stated their distrust of any change. Many of them were even convinced that the protests have been paid for, believing that their organizer is the accused oligarch Vasil Bozhkov, who fled to Dubai and is hiding there because of 18 charges against him. The non-protesters made a connection between the compromising photos and recordings of telephone conversations with the image and voice of the Prime Minister, which appeared in the public space months before the protests in 2020, and the subsequent public discontent in the country. The entourage of theis oligarch was spotted in the streets among the crowds [3].

Despite the political insecurity, Prime Minister Boyko Borissov refused to resign, citing the impending severe crisis in the world and in particular - in the country, caused by the COVID-19 pandemic, believing that the opposition will "break Bulgaria" if the ruling political party *CEDB* relinquishes power. He believeed that the ruling party has

contributed much to the country's development, including building a number of road networks. According to him, the latest political scandals related to his name were a well-targeted scenario between the the political parties *Movement for Rights and Freedoms* (*MRF*) and *Democratic Bulgaria* (*DB*). He also accused the President of failing to unite the nation in a crisis situation like this. Borissov's tactic was to "exhaust" the protesters in the hope that they will receive insignificant international support, thus reducing the strength of the protest to a routine background during the remainung months for the regular Parliamentary elections.

2 Protests in Bulgaria

The protests in 2020 in Bulgaria were not fragmentary, but rather a complete process, which sometimes escalated, sometimes subsided, but did not stop completely. In recent years in Bulgaria, there has been a cycle of strong protest waves over approximately 7 years - 1990, 1997, 2013–2014 and 2020–2021 with weaker protest outbreaks between the years. The similarity between these protests is that they are the result of a general sense of injustice in people and are provoked by the demand for defending the human rights. The differences between the protests in the years from 2013 to 2021 are in the specific motivation that provokes social discontent - economic insecurity, disagreement with political, social, environmental and other decisions and ideas, as well as dissatisfaction with corruption in the country, etc. There are also differences in the main characteristics of the various protests in their symbols and messages and especially in the results achieved.

It is peculiar that the debates related to the protests in the country in the years from 2013 to 2020, in certain periods of time become one of the most discussed topics in the Bulgarian public space. Discussions are characterized by strong polarization and extreme expression of opinions, including by politicians and opinion leaders. It is no coincidence that the present study also raises the question of the extent to which media influence and shape the public's attitudes on sensitive and controversial topics and the extent to which it informs audiences objectively and impartially.

In the modern technologically mediated information and communication environment we are witnessing the constant interaction between traditional media, social media and social networks. Each of these participants in the media ecosystem increasingly influences the others and together they influence the formation of public opinion. "It is in the relationships between traditional media, blogosphere, social networks and mobile communications that the characteristics of the new media ecosystem can be found" [4].

The protests over the years have been widely covered by traditional media, private sites, social media and social networks, and even foreign media. Depending on the media policy of the various media, the comments and attitudes about the protests in the country also varied. Some of the social media zealously supported the public discontent and criticized the government of *CEDB* in the published analyzes. According to others, the protests in 2020 were "part of a dangerous strategy to destabilize the state by dismantling the authorities and institutions" [5]. Some traditional media also criticized the protesters' actions and demands and defended the ruling party. Foreign media tended to objectively cover the situation in Bulgaria [6]. Even though many Bulgarian media also covered the events impartially [7].

Characteristics of the Protests. It is typical for the protests in Bulgaria from 2020 that they cannot be identified as "right", "left", "anti-communist", etc., as they are heterogeneous and involve parties, groups and organizations with clearly incompatible political views, united by a common goal - to receive the resignations of the government of Boyko Borissov, the Chief Prosecutor Ivan Geshev and to provoke early elections. These protests can be described as anti-corruption and ethical.

Like the winter protests in 2013 in the country, those of 2020 did not remain localized only in Sofia, as cities such as Burgas, Varna, Plovdiv were also protesting, as well as supported by thousands of compatriots living abroad – in Great Britain, Ireland, Austria, Germany, USA, etc. Thanks to the technological developments, the protests in 2020 were broadcasted on social networks and YouTube channels, mostly by volunteers (bloggers and other protesters), some television stations and the social network Facebook also broadcasted what was happening live to demonstrate full transparency of events.

A significant difference between the protests from 2013 to 2020 is that the last ones happened in a crisis of public trust with the government, and with the media. The protesters in 2020 had a negative, at times even aggressive, attitude towards the media representatives coveing in person the course of the protests. The behavior of the crowds towards the media clearly showed the complete loss of trust in journalism as a fourth power, showing that society seemed more to be used as a curling iron for political and power purposes by media owners.

The protests in 2020 were against the whole corrupt system, because of which Bulgaria cannot push itself up from the bottom for years. In view of the attempts to attack some journalistic teams, which covered the civil protests on the ground, on July 14, 2020, the Council for electronic media (the national regulatory body for radio and TV programs) expressed a position with a Declaration in Defense of Free and Responsible Media, which stated that any attack on or obstruction of the media work is an attack on the achievements of democracy.

Although public discontent in 2020 lasted more than half a year, the main goal - the resignation of the Government and the Attorney General of the Republic, was not achieved. However, the protest managed to achieve the resignation of key ministers, similar to the protests of late 2018 and early 2019.

In 2020, the heads of Ministries of Finance, Interior, Economy, Tourism and Justice left power. The Minister of Health, who resigned from his post in the Ministry of Health, but took over the Ministry of Finance, also suffered a castling. The head of the National Security Service was also replaced. All these executive shifts led to the conclusion that more frequent protests provoke changes in policy and to personal resignations. In addition, it is evident in the sequence of protests over the years that the maturation of civil society in Bulgaria is taking shape. We are also witnessing the moral gradation of public demands.

Characteristic of the 2020 protests is that they resonate so far beyond the country's borders. As a result of the mass discontent, which lasted more than half a year, the voice of the Bulgarian society reached a number of countries in the European Union. As a result, the Committee on Civil Liberties in the European Parliament (LIBE) voted in favor of a Resolution supporting anti-government protests in Bulgaria. The EP is in solidarity with the legitimate demands of the people, it said. MEPs deeply regret that "developments in Bulgaria have led to a significant deterioration in respect for the rule

of law, democracy and fundamental rights, including the independence of the judiciary, the separation of powers, the fight against corruption and media freedom, and expresses its solidarity with the people of Bulgaria in their legitimate demands and aspirations for justice, transparency, accountability and democracy". MEPs were worried about the lack of convictions for corruption at the highest levels of government in our country. In addition, according to them, there is a suspicion that the money from EU funds goes to entities close to the ruling party" [8].

Performing such a symbolic act is a precedent. This moral action unequivocally shows that despite the failure of the protest to overthrow the Government in the country and the Prosecutor General of the Republic, it achieved very important support from the "European family", of which Bulgaria is a part.

3 Technology and Protests

The intense technological developments facilitate the society itself and the ruling party to communicate better with media and society via Internet. The chance to communicate directly in real time with potential voters, thus avoiding the interpretations of the mediator, has growing preference by political leaders. Accordingly, the ability of society to communicate directly through social media and social networks allows millions of people to unite around different ideas. The extraordinary circumstances related to the spread of the Corona virus further catalyzed the process, as they enhanced audiences and institutions to redirect their way of communication mainly to the digital environment, thus making communication via social networks, regardless of the age of the audiences, even more popular. Many politicians chose this option as the preferred channel for their messages, including to the media, instead of using the usual press conferences. Very often, people's discussions in social media and social networks lead to emotional outbursts and protests. This raises the question of the growing importance of social networks in the process of communication between humans themselves and between society and the political leaders. It leads to the reasonable assumption that this model of interaction will rigorously develop in future, especially in times of social isolation. That is why it is of particular importance to outline the trends and the peculiarities of the developments of these online relationships.

The subject of the present study is the relationship between digital and real environment through computerization. The hypothesis is that in critical times of crises, such as the Corona virus pandemic and the outbreak of Bulgarian protests during anti-epidemiological measures, the role and influence of high technology is growing and becoming a catalyst for change. The possibility of direct communication between strangers, connected by common ideas, of fast exchange of different information (texts, photos and videos), as well as the posibility of belonging to different groups in social networks, bringing a sense of security and provoking more courage, is a prerequisite for the faster production of civil discontent in online space. Digital communication is a generator of faster and bolder change. As Irena Todorova writes in her article "The Internet Influence on Political Participation Level" [9], the Internet creates an opportunity for the consumer to be engaged in some ideas, to be informed, to participate. Thus it becomes a socializing factor. Citizens find there opportunities to influence and unite,

even to enrich their political culture. The dissemination of disparate information on the web and the opportunity of each user to access it creates the strength of the new digital society.

It is an indisputable fact that digital communication between contemporary audiences increasingly fills the need for intercourse. In the context of the Corona virus pandemic, online communication occupies an even higher percentage of interaction between people, regardless of their age differences. The virtual world of the Internet is attracting more and more people from different professions, interests and beliefs. Now every user of the largest social network Facebook can join any of the existing groups and share, enrich or refute the ideas of other supporters. And while before the existence of Internet people organized a protest through information diseminated via the traditional media and communication means or spread people themselves, today, thanks to the high technology that is invariably present in our daily lives, it is possible to organize millions of people in a very short time. Or, as Iliya Valkov writes, civic mobilization in social networks is a form of spontaneous self-organization, an emotional manifestation motivated to achieve a specific goal. Consumers tend to infect themselves with information, problems, ratings, resentment and admiration. They are subordinated to the established reflex - "sharing and informing", which has become a necessity in the online space. Thus, "self-infection" becomes a mobilizing effect that can take to the streets in the form of subscriptions, marches, flash mobs, protests. At the beginning of the 21st century, social networks are claiming to be a laboratory for public opinion and an indicator of increased social tension. Numerous examples show that with the development of social media in Bulgaria, the number of protests and civil actions of various communities is growing [10]. Example of the power of sotial networks is precisely the start of the protests in 2020. Public outrage at the actions of the prosecution blew up the social network and poured into the square in front of the Council of Ministers.

"With the increasing use of the Internet, a new type of protest culture is apearng that goes out from the traditional notion of political participation - 'activism in front of the monitor'. One of the most common questions that arise around such forms of political participation is focused on their coherence," points out Irena Todorova in her article "The Internet Influence on Political Participation Level". She somehow resembles the online space with a kind of democracy in which anyone can express itself and become a leader, as long as the audience recognizes it as such, and any well-appreciated idea could become master [9].

The different way of how traditional media, on the one hand, and social networks and social media, on the other, are functioning, gives rise to diversity and greater objectivity in the coverage of what is happening during the protests in 2020. Traditional media relied on professional models of work, as well as on professionally trained teams of specialists – reporters, cameramen, photographers, etc. The representatives who write on social networks and social media more often are non-professionals, people with different backgrounds and opinions. Exactly this diversity of ideas, perceptions and different points of view on the same issue that is spreading on social media and social networks, is the alternative information channel that complements traditional media.

In social networks there are polar opinions on some topics, as well as an event can be reflected in radically different ways, depending on the positions of the author. Very

often the protesters themselves publish videos of specific public discontent, comment on what happened, exchange ideas. Thanks to the hight technologies it is now very easy for a random event to be captured on a photo or video and to be published immediately on social networks or social media. These unprofessional photos and reports are live and help to disseminate information faster and more widely.

There is a similar example in world history as the case of the OccupyWallStreet protests in the United States, when in the fall of 2011, a war broke out in the social media arena. On the one hand, the protesters uploaded photos and videos of police violence, showing their point of view. As a result, they gain serious civic support. New York City police, on the other hand, insured themselves and recorded how they instructed protesters who did not follow instructions. They then arrested about 800 people and uploaded the video to social media to show how they acted. One thing is for sure - thanks to social media, information is spreading like wildfire [11]. Equally quick are the reactions of experts, politicians, society, etc.

Even the Turkish Prime Minister Erdogan said in June 2014 about the protests in the country: There is a scourge called Twitter. The best examples of lies can be found there. For me, social media is the biggest scourge for society. This in itself speaks to the strength of social networks and the fact that they are already a serious opponent of government, politicians and companies.

4 Conclusion

The research method is analysis. As a result of the study, it may be concluded that the protests in Bulgaria in 2020 ran from the virtual space to the real environment and back through social networks and social media. The present study also tracks the changing communication patterns between society and Government through mass media, social media and social networks, analyzing the main messages, symbols, slogans and characteristics of the protests. It analyses the culture language of the protests, as well as the interaction between the media ecosystem and the economic, political and socio-cultural system in the modern democratic society in times of crisis. Social networks are the catalyst and organizer of the protests in the country. They helped create various movements that first started as Facebook groups. Before taking to the streets, the protests were organized on the Internet through social networks. Social networks were changing the way protests are organized and conducted. They are becoming a powerful weapon in the hands of protesters. During the protests, social networks helped to spread information and news quickly, making them a powerful channel of communication. The existence of social networks and social media changes the ways of organizing, conducting and covering protests in contemporary societies. The network's power is to instantly inform, unite the masses and take them out of the virtual space into the real one. New ideas and leaders are being born on social networks and social media. Networks act as a catalyst for protests, and their power increases in the context of social distance (caused by the Corona virus). As a result of the possibilities of new technologies the ruling party and the society use social networks for better communication.

Acknowledgments. The present study was carried out in the framework of the DATASOC Project KP-06-M35/4 - 18.12.2019 of the National Scientific Fund.

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Effectiveness of Disaster Mitigation Information by National Disaster Relief Agency in Indonesia

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Abstract. This paper aims to determine the function and relationship between social media and the dissemination of disaster mitigation information by the National Disaster Relief Agency. The method used in this research is Q-DAS (Qualitative Data Analysis Software) Nvivo 12 plus. Stages of data analysis with Nvivo 12 plus captured data, data import, data coding, data classification, and data display. This study's findings reveal that the National Disaster Relief Agency has made various efforts related to disaster mitigation by conveying the substance of information through the hashtags #bersatulawancovid19 and #infobencanaabnpb, which dominate the trend with a percentage of 47% and 22%.

Keywords: Social media · Disaster mitigation · Information · National disaster relief agency

1 Introduction

Disasters, both natural and artificial, are worrying and frightening to humans. Even the culture of the nation can be affected by the fear of disaster [1]. The industrial era 4.0 is an era of public information openness [2]. Therefore, many media support communication patterns and government activities [3]. This information disclosure makes it easier for the public to communicate and control the activities carried out by the government [4]. Social media communication patterns become easy and open because their designs tend to be more open to the public. The way of spreading the message, which tends to be free, aims to be immediately recognized by the wider community [1]. Also, social media is an information tool through which the authorities can provide information by identifying the scene and transferring data in real-time [5]. This can be a problem, especially in terms of the accuracy or validity of the news. With many social media users and the broader distribution of information, communication patterns have become uncontrollable [6].

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 122–129, 2022.
https://doi.org/10.1007/978-3-030-85540-6_16

With technology development, the government should provide news and data quickly and quickly [1]. Social media's extensive use is one model of government communication in realizing good governance, particularly transparency [7]. Given the concept of good governance, the government must be transparent and open to the public [4]. Therefore, information technology must be maximized appropriately to support government running and create good governance [8].

This study uses Q-DAS (Qualitative Data Analysis Software) Nvivo 12 plus to collect data and analyze data with graph analysis, cluster analysis, and cloud word analysis. The purpose of this research is to see the effectiveness of the strategy for delivering information on disaster mitigation by the National Disaster Relief Agency through its Twitter account. The focus of this research is the relevance of providing disaster mitigation information through social media. This study seeks to answer substantive questions: What are the functions and links between social media and the dissemination of disaster mitigation information conveyed by the National Disaster Relief Agency?

2 Literature Review

2.1 Social Media Twitter as Public Communication for Disaster Mitigation

Social media is essential for risk communication regarding any event, including a disaster. This study analyzes the current status quo by examining time-series, network, and content [8]. The emergence of social media has been able to change the interaction patterns and habits of society [5]. Updating retweets, reply tweets and mentioning someone has become a part of everyday life for internet users [9]. Warnings, coming from established stakeholders, are the most common messages, making them essential for risk communication [1]. Due to the lack of information on protective measures and recommendations for social media behaviour, more helpful info is needed to disseminate [10]. Effectiveness is the relationship between output and objectives, the more significant the contribution (contribution) of the production to achieving goals, the more effective a program or activity is [11]. Based on this opinion, that effectiveness has a reciprocal relationship between output and objectives, the more effective the output contribution, the more effective a program or activity is [12]. Effectiveness focuses on the results (outcomes), programs, or activities that are considered effective if the resulting output can meet the expected objectives or spend wisely [10]. Advances in technology allow the government to disseminate information on disaster mitigation more effectively.

2.2 Disaster Mitigation

Disaster Management Cycle (DMC). These authors list the four phases of DMCs: preparedness, response, rehabilitation, and mitigation [4]. Humanitarian logistics research seeks to link disaster preparedness and response to disasters [1]. Central to the working model for disaster preparedness decisions is the inventory proposition and network planning [1]. Supplies modelled in the literature range from in-kind assistance such as water and food to assets such as vehicles and electric generators [13]. However, studying the relationship between disaster preparedness and disaster response, the existing literature

on operations management largely ignores the relationship between disaster mitigation and disaster preparedness [4]. The substitution effect between disaster mitigation and disaster preparedness is explained [1]. This research is based on disaster study literature on disaster mitigation and preparedness [10].

Community Involvement in Disaster Management. Community involvement is one reason a more resilient community results in more effective disaster response [1]. Adding disaster mitigation in the future will benefit from more empowerment of local communities [14]. A charge is about engaging communities in active dialogue with stakeholders such as the government to identify their assets and needs, which ultimately leads to increasing the capacity of communities to prepare for disasters, respond to, rehabilitate, and reduce the future [4]. Also, communities are first responders and are actively engaged in humanitarian needs to save lives and reduce human suffering [1]. Other stakeholders, such as the government and the private sector, can also facilitate community engagement [12]. By using document analysis, social workers can increase community involvement in disaster management [15].

3 Method

This study uses the Nvivo 12 plus. Nvivo 12 plus as a qualitative analysis tool displays data in a quantitative form called qualitative to quantitative analysis. This analysis produces quality data whose validity can be proven scientifically [16]. The qualitative approach provides exploration and description of disaster mitigation, illustrations to provide information, and explains data efficiently. The research data comes from the Twitter account of the National Disaster Relief Agency (@BNPB_Indonesia). Nvivo 12 plus in this study is graph analysis, cluster analysis, and cloud word analysis. The use of NVIVO as an analysis tool has five stages: (1) capturing data, (2) importing data, (3) coding data, (4) data classification, and (5) displaying data. The information shown is submitted to the data using qualitative data analysis methods.

4 Results and Discussion

4.1 Twitter Social Media Activity About Disaster Mitigation

A significant interaction pattern has occurred on the National Disaster Relief Agency's Twitter account in recent months based on additional data. The delivery of this information shows a comparison of the dynamics of different interactions in the previous two years. Below is the number of tweets from @BNPB_Indonesia, viewed from June 2020 to February 2021 (Fig. 1).

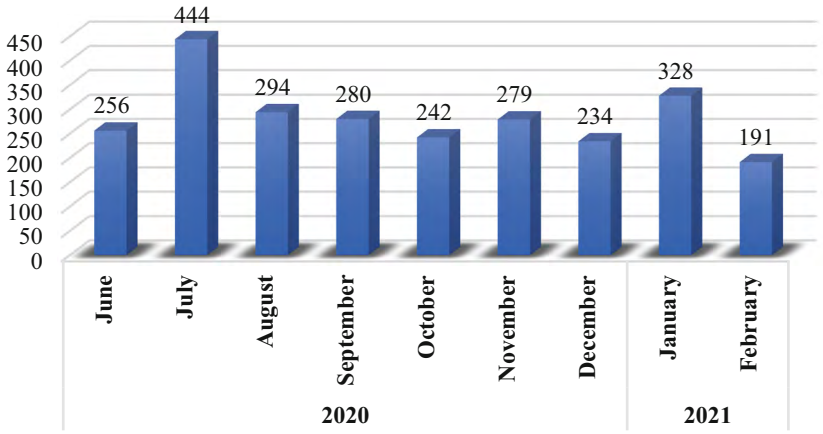


Fig. 1. Twitter activity

Information provided by @BNPB_Indonesia shows an increasing trend every month because the dynamics of disasters in Indonesia every month and year are different. Natural disasters dominate the dissemination of information via Twitter, then accelerated handling, mitigation efforts, and the government updating data related to the tragedy (Fig. 2).

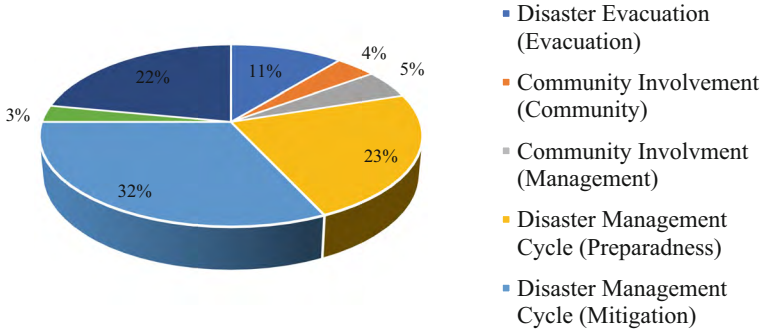


Fig. 2. Disaster mitigation information

The picture above shows the aspects of the disaster mitigation movement instrument presented by the National Disaster Relief Agency, which is dominated by the disaster management mitigation cycle. The delivery of disaster mitigation information by the National Disaster Relief Agency has a substantially dynamic content proportion of the three indicators and sub-indicators. The disaster management cycle indicator has the highest percentage at 80%. In comparison, it is divided into four sub-indicators: preparedness with a 23% level, mitigation with a group of 32% or the highest, rehabilitation with 3% or the lowest. And a response of 22%. In the second indicator, community involvement is 11%, divided into two sub-indicators: community with a level of 4% and

management with a group of 5%. In the third indicator, disaster evacuation has a figure of 11%. The most dominant communication carried out by @BNPB_Indonesia is towards disaster management, which is dominated by the topic of disaster mitigation. BNPB recommends that the community take action as disaster preparedness. Dissemination of information related to disaster mitigation is followed up through the BNPB program in collaboration with various related agencies. Dissemination of disaster mitigation information includes the following.

4.2 Effectiveness of Disseminating Disaster Mitigation Information

Disclosure of information on disaster mitigation efforts through the @BNPB_Indonesia post is carried out by government agencies, media, and government officials. The strategy for submitting mentions and hashtags is to convey information to the public (Fig. 3).

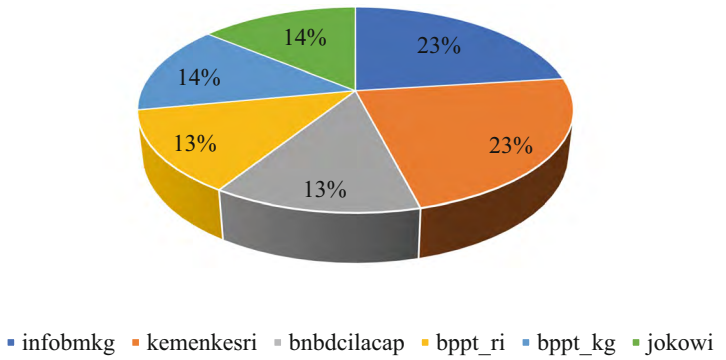


Fig. 3. Mention twitter account

The Mention feature is one of Twitter's hallmarks. Every tweet or tweet will go viral if spread using the Mention and Retweet features. The first time you create a Twitter account, users are required to create a username or username. This username's function is to make it easier for users to communicate with other users on Twitter. The @BNPB_Indonesia account is seen frequently interacting with the @infobmkg and @kemenkesri accounts which show 23%. This data proves that the two reports often carry out social media activities discussing disaster mitigation through the hashtag # bersatulinterviewsovid19 and #infobencanaabnpb. The dissemination of information through social media is considered more effective through this trend because it can convey broad objectives by mentioning various related accounts (Fig. 4).

One of the exciting features of Twitter is that we can find out in real-time what things are currently trending or also known as hashtags. Disclosure of information related to disaster mitigation efforts submitted by the National Disaster Relief Agency uses various hashtags to classify each substance. # converse interviewovid19 has a total of 961 or 47%. The general nature of disaster mitigation efforts is focused on the dissemination stage of information through the hashtag #infobencanaabnpb.

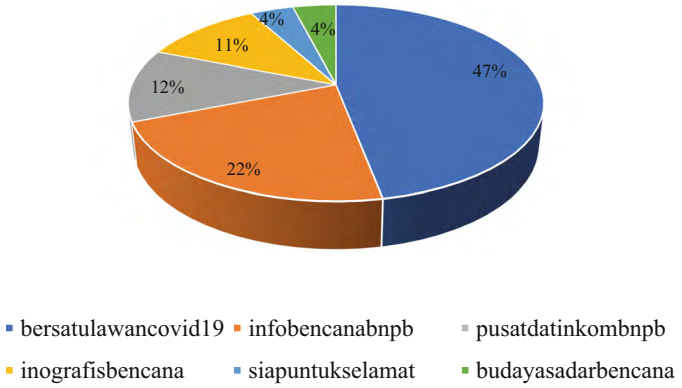


Fig. 4. Twitter social media hashtags

The information conveyed by the @BNPB_Indonesia account uses several hashtag messages to carry out various disaster mitigation awareness campaigns, such as # bersatulinterviewovid19, which has a percentage of 47% or the highest. The focus of #infobencanaabnpb is to socialize and provide education about disaster mitigation efforts to the broader community. The message contains #infobencanaabnpb from the official @BNPB_Indonesia account. Important information message #infobencanaabnpb has a percentage of 22%. Information related to this hashtag is used by @BNPB_Indonesia to invite all people to have an attitude of preparedness in facing disasters in Indonesia. Meanwhile, the trends of #budayasadarbencana and # ready to survive to show the lowest percentage figures.

5 Conclusion

BNPB uses Twitter for a valuable function, disseminating information about disasters. @BNPB_Indonesia followers get a positive influence from the information or news published. Previously, they did not know or even did not know anything about natural disasters. However, gradually they have not turned into everyday actions. Disseminating information via Twitter is technically practical and efficient because it does not require significant capital and is up to date with the times. The effectiveness of the dissemination of disaster mitigation information is disseminated through mentions from several of the most dominant accounts, namely @infobmkg and @kemenkesri, each with a percentage of 23%. The dissemination of this information was followed by a trend spread through the hashtag # bersatul interviewovid19 which dominated by 47%, and #infobencanaabnpb by 22%. Thus, the authors conclude that the information provided by BNPB is about the timing of the disaster and the implementation of disaster management, carried out effectively through social media Twitter. This study's limitation is that this study only examines disaster mitigation from @BNPB_Indonesia from 2020 to 2021.

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Technology for Governance: Comparison of Disaster Information Mitigation of COVID-19 in Jakarta and West Java

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Abstract. The purpose of this study is to compare information on COVID-19 mitigation in Indonesia through the Twitter accounts @dinkesJKT and @pikobar_jabar and analyze them using a qualitative descriptive approach. Meanwhile, this research method used the NVivo 12 Plus application to collect data, including word frequency and chemical crosstab. This study's findings or novelty were the four message variables or mitigation information. They were health protocol call information, COVID-19 vaccination, COVID-19 data, and the PSBB (large-scale social restrictions) policy. Furthermore, the difference or comparison regarding the two Twitter accounts' contents was the quantity of information provision. The @dinkesJKT account in one year tweeted 1078 posts, and the @pikobar_jabar account had 2,624 Tweets. From this data, Jakarta Province has used Twitter more heavily to provide information on COVID-19 mitigation. The difference in mitigation information from the two Twitter accounts was the dominance of different messages in quantity.

Keywords: Information · Mitigation · Twitter · COVID-19

1 Introduction

In the digital era, many actors can use social media. Apart from individuals, the government uses social media to interact with the community virtually to increase participation and accountability. New media such as the internet, applications, and social media create a new interaction style between the government and society [1]. They can be connected by wireless connection or called open government and electronic governance. For example, the United States government, through President Obama in 2009, appealed to all states or state governments to carry out the open government with the help of social media to open access to public involvement in policymaking, government transparency, public information, and collaboration between elements [2]. In Indonesia, social media

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 130–137, 2022.
https://doi.org/10.1007/978-3-030-85540-6_17

as a strategy for public communication related to information on the COVID-19 pandemic mitigation is being carried out by Jakarta's provincial government or the capital city of Jakarta and West Java Province. The two provinces have been using Twitter social media to provide information on COVID-19 mitigation. This strategy is relevant to the number of Twitter users in Indonesia who are ranked ninth in the world according to Social & Hootsuite survey in 2019 [3]. The Jakarta provincial health office and during the COVID-19 pandemic significantly mitigated COVID-19 information to the people of Jakarta.

Furthermore, @pikobar_jabar is the official account used for information and coordination between the West Java government and the community regarding the COVID-19 pandemic, and both have followers of more than 5 thousand people. The activities of the two Twitter accounts mitigate information through their respective status or tweet. For example, the @dinkesJKT account using the hashtag #JakartaTanggapCovid19 (west java hashtag responds to covid) and @pikobar_jabar makes the spread of the hashtag #JabarTanggapCovid19 (West Java hashtag responds to COVID-19). Also, referring to the two accounts' tweet activity observation, four types of information on COVID-19 mitigation were found. They were about COVID-19 health protocol education, the disclosure of COVID-19 data, information about vaccines, and information on PSBB (Large-Scale Social Restrictions) policies.

Social media needs to pay attention to various aspects through the message strategy to spread information about COVID-19 mitigation without interruption, influence people's behavior, and protect them from the pandemic [4]. Furthermore, communication between the government through social media and the community is connected on Twitter. This two-way communication model uses the available retweet and comment features [5]. The government must provide correct information regarding disaster management mitigation, like during the COVID-19 pandemic [6]. For example, countries with practiced information and communication technology or ICT through social media are California and San Francisco. They have used Twitter as a means of public communication and disaster information mitigation [7]. From the explanation above, this study aims to find out the comparison of information on the COVID-19 pandemic disaster mitigation between the Jakarta and the West Java provincial governments. From these comparisons, the differences in message focus and patterns of relations with the community, in this case, netizens, will be revealed.

2 Literature Review

2.1 Technology for Government

ICT or information technology and information have become part of the government's work to improve performance, including leadership effectiveness, public participation, and information disclosure [8]. However, the principal value in using information technology in government is to create a public space to create a debate between stakeholders or between government and civil society in virtual space [9]. The theory of public space in politics and democracy introduced by Jurgen Habermas can be categorized as an old or classic approach [10]. Technology in government is a new approach in government electronics that has a two-way communication pattern.

Furthermore, in using technology for the government, the primary value in this concept is public participation in the realm of e-government and e participation. Referring to Arnstein's (1969), the participation method includes three crucial parts. They are public participation, interaction and discussion, and joint decision-making. The three parts can be done digitally or virtually with internet technology as a tool [11]. The continuation of technology in the government's work environment for a long time will create a new system in state life. This system is called a smart city. Indicators of success in applying technology must be implemented to achieve a smart city-based government. They include civic participation, governance including participation, open government, and data transparency [12].

2.2 Social Media Government and Related Disaster Communication

Social media is a tool for government communicators to communicate with the community. Using social media, the government can connect with the community at any time, both of which have been integrated as an adaptation and innovation for government work progress [13]. Collaboration between government and social media in e-government practices in social scientist studies can positively impact public responsibility and trust in the government [14]. However, with virtual or e-government communication channels, social media is not the primary communication tool to reach public participation because virtual communication still has shortcomings. For example, Santander Smart city in Spain conducts direct meetings to continue programs communicated through social media [15].

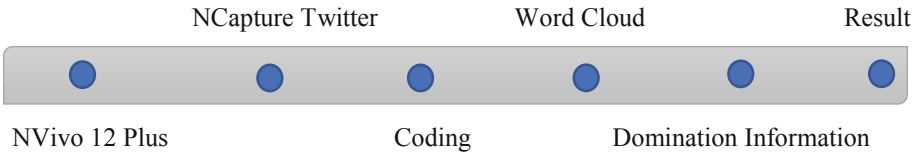
For example, Seok-Jin Eom (2016) explains the example of the Mayor of Seoul-South Korea taking a role through social media by becoming an actor of communication with the public via Twitter. This activity increases government responsibility to overcome dialectical disorders between the government and the public [16]. Furthermore, the critical role of social media for the government is as a medium for disaster communication and to provide disaster preparedness messages as public information [17]. Information about disaster mitigation by the government can officially become valid data for the community in dealing with disasters [18]. In an emergency, social media is not only a coordination and communication tool used by the government but has become part of a tool towards humanity as a preparedness measure disaster [19], referring to Takashi et al. (2015), who categorized the function of social media as a means of disaster communication, as shown in Table 1 below.

Table 1. Category and description of social media use (Takashi et al. 2015)

No.	Category social media usage	Descriptions
1	Situational report	Information regarding disaster emergencies, mitigation, handling or preparedness used by individuals and organizations
2	Government critics	Information from official government social media to provide public information during a disaster emergency
3	Relief effort coordination	Use of social media for philanthropic activities or volunteering in cases of disaster emergencies

3 Research Methods

This study used a qualitative description approach, and the primary data sources of this study were the Twitter accounts (@dinkesJKT and @pikobar_jabar). Furthermore, the data were coded using the NVivo 12 plus research application to determine each coding Twitter account's metadata classification. Researchers would describe the NVivo process results to determine a comparison or difference regarding the two accounts' mitigation information.



4 Analysis, Finding and Discussion

4.1 Information Topic Intensity on Official Twitter Government

Figure 1 shows the number of word frequencies used by Twitter users in the Jakarta and West Java governments. In the @dinkesJKT account, the word "Health" is dominant to carry out a Health campaign during COVID-19. The word "information" is often used and relaunched to the frequency of information about extensive COVID-19 data in the @dinkesJKT account.



Fig. 1. Word Frequency @dinkesJKT

In Fig. 2, the words "Covid", "Vaccination", and "Confirmation" become the three dominant words in @pikobar_jabar's tweet activity during the COVID-19 pandemic. A large portion of information tweets about access to Covid data as part of public services and vaccinations as medical methods to fight the COVID-19 virus is the West Java government's focus.



Fig. 2. Word Frequency @pikobar_jabar

4.2 Domination Information Message on @dinkesJKT and @pikobar_jabar

The search results using the NVivo 12 plus method, the @dinkesJKT account has 3 COVID-19 mitigation information, which is constantly updated on the Twitter timeline directly. Figure 3 is a diagram of the domination of existing information. Information messages about COVID-19 and data access development dominate and become a priority for the Jakarta Health Office. The second domination is vaccination information which contextually, in March 2021, the government will be distributing vaccines in every region in Indonesia. The health protocol issue is the third dominant as a mitigation message.

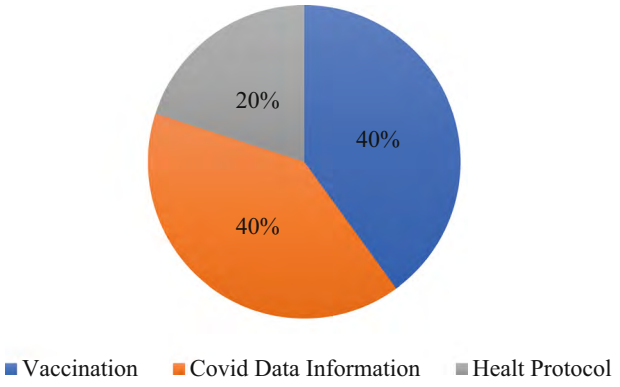


Fig. 3. Variable's domination of message on @dinkesJKT

Different from the official Twitter account of the Jakarta Provincial Health Office in Fig. 4, the West Java provincial government focuses on four mitigation information messages for COVID-19. They are the dominance of messages about health protocols, COVID-10 data accesses for information services to West Java people, vaccination provided evenly by West Java Province, and the PSBB (large-scale social restrictions) to avoid the COVID-19 virus.

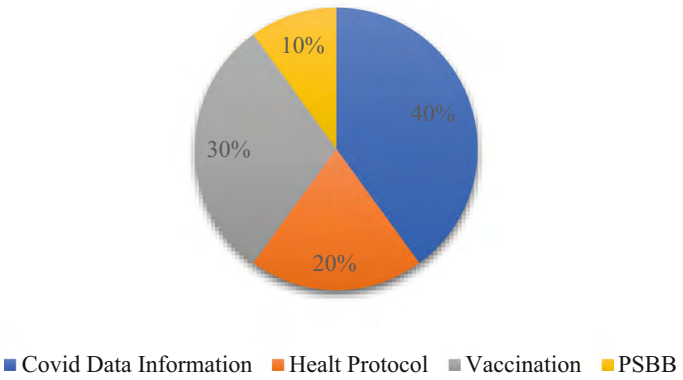


Fig. 4. Variable's domination of message on @pikobar_jabar

4.3 Comparison Table of Mitigation Information

In Table 2 is a comparison of COVID 19 mitigation information messages by the provinces of Jakarta and West Java. The authors find differences that the Jakarta government focuses on providing information about COVID vaccination, in the sociological context of Jakarta as the capital of Indonesia being the first province to receive vaccines, this is also due to the central geographic government located in Jakarta, so information and education messages about vaccination are the main focus.

Table 2. Comparison table of mitigation information

No.	Twiter account	Comparison mitigation information
1	Dinkes_JKT	The Jakarta Provincial Health Office, through a Twitter account, provides a lot of information about Covid vaccination (40%)
2	Pikobar_jabar	West Java Province via Twitter account provides a lot of information about Covid data information (40%)

In West Java, the message of Covid mitigation information focuses on the transparency of Covid data information. The percentage of information messages is as much as 40%. In the coding process and analysis with NVivo, data transparency includes the number of confirmed cases of Covid, hospital facilities for treatment and isolation, and the number of cases recovered from Covid.

5 Conclusion, Research Limitations and Recommendations for Further Research

The digital era has made the government adapt to using communication technology through the mass media to carry out information on mitigating COVID-19. Unlimited communication through wireless channels helps the effectiveness and efficiency of government work in public services. In the mass of the COVID-19 pandemic, Jakarta and West Java's provinces are actively communicating virtually through the official Twitter accounts @dinkesJKT and @pikobar_Jabar.

The results concluded in this study include COVID-19 mitigation information on the Jakarta and West Java Twitter accounts. There are four variables of mitigation messages, such as information and data access, COVID-19 vaccine information, the health protocol appeal, and PSBB (large-scale social restrictions). This research's limit is to determine the variable of COVID-19 mitigation information messages tweeted by @dinkesJKT and @pikobar_jabar during one year. Recommendations for future research development with government mass media activities are to analyze tweets, retweets and hashtags in communication activities on Twitter to extend the analysis.

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Social Media as a Tool for Social Protest Movement Related to Alcohol Investments in Indonesia

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Abstract. This paper examines social media's role as a social protest movement and the scattered narrative related to the Presidential Decrees, which opens up opportunities for alcohol investment in Indonesia and understands the narrative content spread on social media. The data was obtained from Twitter with hashtags #tolakinvestasimiras, #rezimperusakmoral, #batalkanperpresmiras. This study used Q-DAS (Qualitative Data Analysis Software) Nvivo 12 Plus. This study's results reveal that the protest movement carried out through hashtags related to refusal to invest in alcohol is based on disadvantages and increased levels of consumption. It is based on religious rules considering that the majority of Indonesian people are Muslim. Still besides, health, crime rates, and applicable laws also make the basis for refusing alcohol investment. As an alternative to the most influential social movements, social media shows how The social protest movement through this hashtag shows results with removing alcohol investment attachments.

Keywords: Social media · Social movements · Alcohol investment Indonesia · Government

1 Introduction

The Indonesian government issued Presidential Decree number 10 of 2021 concerning the Investment Business Field on February 2, 2021, as a law and legal product derived from the Employment Copyright Act. It then received an inadequate response through social media, which then formed a social movement through the hashtag #miras, #batalkanperpresmiras (cancel alcohol regulations), #rezimperusakmoral (regime of moral destruction), #mabuk, #tolakinvestasimiras (refuse investment alcohol). Social activity is how a collective interaction is based on a group of people with the same identity and viewpoint to resolve political or cultural conflicts. Some also refer to social movements as hashtag activism, in this case, using hashtags to disseminate information and as an initial form of action, through this kind of digital activism [1]. A social movement

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 138–146, 2022.
https://doi.org/10.1007/978-3-030-85540-6_18

produces social actions (e.g., political campaigns, protests, demonstrations, petitions) in which the ultimate goal of an action taken in a social direction is to "promote or oppose social change at either a systemic or non-systemic level" [2]. With social media's existence, citizen participation in government is increasingly moving online, and initiatives have been passive [3]. Social media provides three essential functions for developing society: providing information, reducing the cost of political participation, and increasing the opposition forces' ability to mobilize [4]. The media can be a generator of public political awareness because of its features that facilitate interactivity, closeness, and easy access for the public [5]. The media's position as a strategy for new social movements plays a role in facilitating reasoning and thinking in mobilizing support [6].

This study focuses on social media and the Social Movement in legalizing alcohol investment which led to protests and a social movement by bombing the hashtags #tolakinvestasimiras, #batalkanperpresmiras, and #rezimperusakmoral. This paper seeks to answer the following questions; Q1 What are the functions and links between social media in the social protest movement regarding alcohol investment?; Q2 What kind of narratives are circulating on social media about alcohol investment?

2 Literature Review

2.1 Social Media in Public Policy

A political scientist like James Anderson identified the concept of public policy. He defined policy as a relatively standard and purposeful action accompanied by an actor or a group of actors overcoming a problem or concern [7]. The results showed that hashtag activism was a catalyst for social movements [8]. The media related to and controlled the policy process in two main methods: (1) by sorting out significant issues so that they can be shown to the public and policymakers (agenda setting), and (2) by questioning policies with a method that sticks to their meaning [9]. Facebook and Twitter, which often share data and political information, are conducive. In this case, a greater level of participation is made through the essence of different steps [10], and because social media contributes to political participation, one of them is blog users, which directly affect online political participation [11].

2.2 Alcohol Policy

The alcohol industry tries to influence marketing regulations, market policies on new specifications, and broad alcohol policies that include marketing regulations. The political activities of the alcohol industry are categorized into how strategy arguments [12]. African countries have implemented various alcohol control policies in price regulation, physical availability, alcohol marketing, and drunk driving [13]. The Korean government has made many efforts to minimize alcohol's dangers by enacting the "National Health Promotion Law" and "Health Plan 2010". So far, the policy has only focused on controlling alcohol consumption. The step needed is to change the alcohol policy's perspective into citizens' health and introduce new policies [14]. The Russian government's step in reducing alcohol consumption is by limiting the sale and purchase of alcoholic

drinks [15]. What underlies the prohibition of alcoholic beverages is unconsciousness (drunk), convulsions, *delirium,* and tremors, disorientation, and even paranoid hallucinations (fear and suspicion) [16]. Research stated that drinking alcohol affected criminal behavior due to the inability to control oneself [17]. Almost all religions have prohibited alcohol consumption and illegal drugs. In Islam, Al-Qur'an in Surah Al-Maida verses 90–91 prohibits alcohol consumption as it covers people's common sense [18].

3 Research Method

This paper used a qualitative approach, which explored and described problems politically, and descriptively provided explanations and descriptions of information and data. This study implemented the Q-DAS (Qualitative Data Analysis Software) Nvivo 12 Plus to collect captured data, import data, encode data, classify data and display data. Data from social media was deemed relevant for users to see political issues trending on social media Twitter. This study used three hashtags which can be seen in Table 1.

Table 1. Hashtags and descriptions

No.	Hashtags	Descriptions
1	#rezimperusakmoral	The hashtag is used to criticize the government for its alcohol investment policy
2	#batalkanperpresmiras	This hashtag is used as a form of intervention against the Perpres
3	#tolakinvestasimiras	This hashtag serves as the submission point of the refusal to invest in alcohol

The N-Capture Nvivo 12 Plus application was used to download content containing hashtags used on Twitter. Word Cloud Frequency would see the domains in the related hashtags above. Crosstab Query saw the extent to which the three hashtags above dominated. Cluster Analysis was used to see the relationship between the three hashtags above. Group Query analysis would determine the community as a social movement that used hashtags to reject alcohol investments.

4 Results and Discussion

4.1 What are the Functions and Links Between Social Media in the Social Protest Movement Regarding Alcohol Investment?

Social media, in this case, has a considerable influence in disseminating information, building narratives, and coordinating action takers and social protest movements. Twitter hashtags used were #tolakinvestasimiras, #rezimperusakmoral, #batalkanperpresmiras. These hashtags were trending on Twitter. In seeing the narrative in the public space in the form of discussion about Rejecting the legalization of alcohol investment in Indonesia,

Word Cloud Analysis of Twitter data was used, showing 250 keywords that appeared as the most frequently used related to alcohol investment rejection. The data was processed from the three hashtags bellow (Fig. 1).



Fig. 1. NVivo12 plus word frequency coding in (*Twitter Hashtags Dominant Word social Movement*)

The hashtags #tolakinvestasimiras #rezimperusakmoral, #batalkanperpresmiras the most frequently appear. Meanwhile, phrases such as #tolaklegalisasimiras, "alcoholic," "investment" indicate that the public assertiveness is seen as firmly rejecting alcohol investment as for other narratives which say "#miraspangkalmaksiat (the alcoholic basic of immorality)," "industry," "legalize. Alcohol investment aims to recover the economy and attract foreign tourists. These hashtags were trending on Twitter. The results of coding by Nvivo 12 Plus with Crosstab Query are in Fig. 2 below.

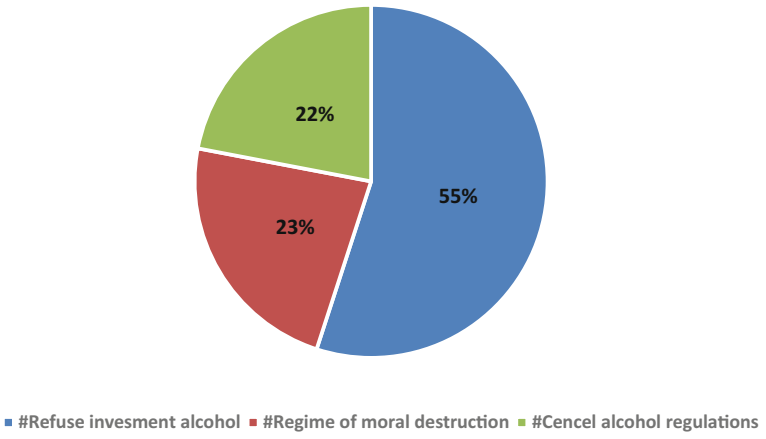


Fig. 2. Nvivo 12 plus coding analysis (*Twitter Hashtags Trending Social Movement*)

The data above was managed using Nvivo 12 Plus on the Crosstab Query tool. The data shows that from the three hashtags, #Refuse investment alcohol becomes the dominant hashtag with 54.00% as a trending hashtag, followed by #Regime of moraldestruction with 23.00%. Meanwhile, #Cancel alcohol regulations is 22.00%, and the lowest with 1.00% is #rezimperusakmoral, while the hashtag #tolakinvestasimiras dominates with a great distance. Social media is the right place to criticize the government regarding policies and social movements for rejecting alcohol investment. From the data above, social protest movements occurred due to irregularities in making policies that are not based on the state's fundamental principles. Therefore, all hashtags above can be represented as anger and disappointment for the Indonesian people represented by Twitter users. This movement is a coordinated politicization, but there is a common viewpoint to see the relationship between all hashtags. The Cluster Analysis tool can be seen in Fig. 3.

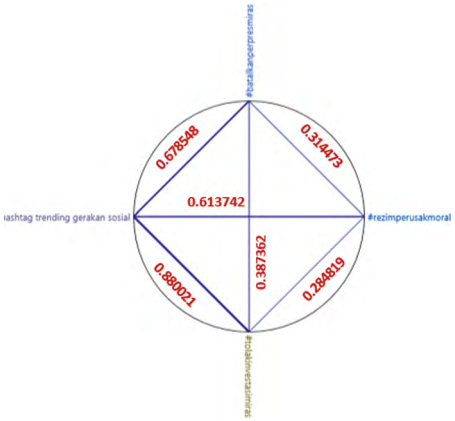


Fig. 3. Nvivo12 plus group query coding (*Cluster Analysis Relationship between the Hashtags Hashtag*)

From the data above, the relation scores are between hashtags, the highest score related to trending hashtags social movement and #tolakinvestasimiras with a relationship value of 0.880021. In this case, the score is between the lower limit of 1 and the upper limit of 0 and 1. They are low because they only appear to use a lower limit of 1 and an upper limit of 0 and 1. The social movement trending hashtag and #batalkanperpresmiras have a relationship value of 0.678548, then the social movement hashtag trending and #rezimperusakmoral have 0.613742. Then, from the data above, the relationship between the hashtag #tolakinvestasimiras and #batalkanperpresmiras has a relation value of 0.387362, while the hashtag #batalkanperpresmiras and #rezimperusakmoral has a relation value of 0.314473.

Meanwhile, #tolakinvestasimiras and #rezimperusakmoral have a relationship value of 0.284819, making the lowest relationship. From the value of each hashtag's relation, all hashtags above are related to one another, but the relationship is interpreted weakly. The community's role is vital in shaping the narrative that is absorbed by the public, represented by netizens or buzzers.

4.2 What Kind of Narratives are Circulating on Social Media About Alcohol Investment?

Social media has recently played an essential role in the Covid-19 pandemic. Almost all activities have been transferred online. It is both easy and an alternative regarding the social protest movement against the legalization of alcohol investment in Indonesia, creating a social protest movement through social media, especially Twitter. Netizens are voicing their rejections through hashtags #Regime of moral destruction, #Refuse investment alcohol #Cancel alcohol regulations. In addition to society individually rejecting, groups, communities, institutions, and organizations play an essential role and are directly in touch with humanity. The mapping of communities that refuse to invest in alcohol can be seen in Fig. 4.

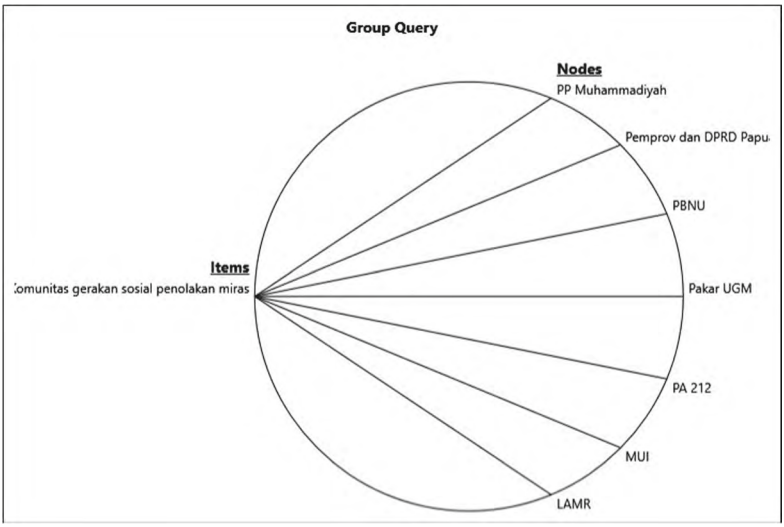


Fig. 4. Nvivo 12 plus group query coding (*Social Movement Community Related to Refusal to Invest in Alcohol*)

From the data above, the community in the social movement related to the protest against alcohol investment consists of PP Muhammadiyah, the Papua Provincial Government and DPRD, PBNU, experts from UGM, PA 212, MUI, LAM, who have vocally rejected alcohol investment in Indonesia. Refusal to invest in alcohol is seen from the religious aspect as a prohibition due to its long-term impact on health, even though it can be seen as a way for economic recovery after the COVID-19 pandemic [19]. Social movements are seen as a collective form of several interest groups with the same goals: solidarity in interactions with elites, opponents, and the government. The main points are drawn in this section regarding social media reactions and the social protest movement related to alcohol investment (Fig. 5).

Data analysis using the crosstab query to see the narrative related to the rejection of alcohol investment processed with Nvivo 12 Plus, with the hashtags above. Based

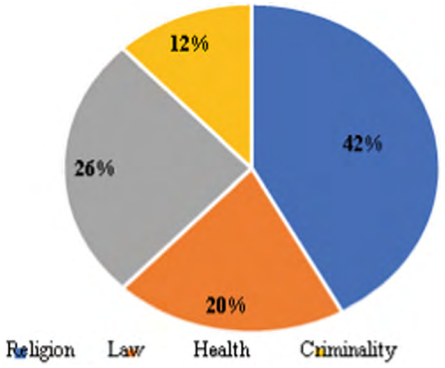


Fig. 5. Nvivo 12 plus analysis crosstab query coding (*Alcohol Investment Refusal Indicator*)

on the literature review, there were four indicators used to see the rejection of alcohol investment, first "Health", "Criminality", "Law", "Religion". Religion reason dominates the alcohol investment rejection, considering that Indonesia has the largest Muslim population worldwide. Also, almost every religion prohibits it. Health is the second reason, considering the significant impact of drinking, while a legal review is the third reason. The Mandate of the 1945 Constitution Article 28, which is assumed to impact after investing in legal alcohol. The fourth reason is the high crime rates even before this investment, as the drinkers will lose consciousness, resulting in criminal acts.

5 Conclusion

Social media has become an alternative part of life as a social protest movement. The users can convey information and issues and coordinate the masses to become a social movement quickly. Social media helps the social protest movement related to alcohol investment which quickly gets netizens. They raised the hashtags against alcohol investment, followed by various movement community inputs, such as PP Muhammadiyah, PBNU followed by nahdiyin residents, MUI, LAMR. With the consideration of religious leaders and experts, the appendix regarding alcohol investment ends in repeal. The right policy by the government will get the people's aspirations.

As this research was limited only to social media data, future researchers are expected to broaden the object study. This not only focuses on social media data but also collaborates with the data that happens in real time and observation. It then sees the community's perspective in the social movement rejection of alcohol investment. As well as how the role of the community is included in the formulation of policies to be taken.

Acknowledgments. This research work has been supported by the Universitas Muhammadiyah Yogyakarta's Master Study Program of Governmental Science. The authors would like to thank reviewers from the international conference on human interaction & emerging technologies.

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Reducing Online Sellers' Opportunistic Behavior: Designing Information Consistency and Information Relevancy

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Abstract. Due to the anonymity of Internet, it has created fertile ground for exacerbating online sellers' opportunistic behavior. Social academic community's interest in studying opportunistic behavior is still developing. This study aims to develop a model that depicts a set of mitigating factors (e.g., information consistency and relevancy) on sellers' opportunistic behavior. A survey was used to collect data from online consumers. The results indicate that fears of seller opportunism mediated the relationship between information consistency and perceived risk. Also, information relevancy moderates the effects of information consistency on fears of seller opportunism. The theoretical and practical implications of this study are discussed.

Keywords: Sellers' opportunistic behavior · Information consistency · Information relevancy

1 Introduction

Due to the physical separation between of sellers and buyers, online consumers are unable to control sellers' behavior. Sellers pursue their own self-interests and act opportunistically whenever possible [1, 2]. The rapid IT technology renders sellers engage in opportunistic behaviors with low cost. Opportunism involve acts such as charging unfair prices, posting inaccurate information, and engaging in online fraud [3–5]. A high level of consumers' fears of seller opportunism will raise their psychological risk perception [6], therefore, more work needs to be done to reduce sellers' opportunistic behavior.

Previous research has focused on enhancing sellers' credibility to reduce opportunistic behavior [7, 8]. It is easy for consumers to get information online, sources of information can be obtained in multiple ways, such as user-generated feedback, word of mouth, and virtual communities. Consistent information from various sources persuades consumers that information is likely to be true. Consistency signals credibility and indicates that online sellers did not engage in opportunistic behavior. Research has argued

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 147–152, 2022.
https://doi.org/10.1007/978-3-030-85540-6_19

that information consistency is a key criterion in reducing psychological risk perception. There has been little research on studying the role of social network information characteristics (e.g., information consistency) on reducing sellers' opportunistic behavior. This paper attempts to investigate the mediating role of fears of seller opportunism on the relationship between information consistency and psychological perceived risks.

The web personalization environment has made the widespread of information relevancy possible [9]. To maximize potential economic benefit, online sellers utilize information relevancy as a marketing strategy in delivering information to persuade consumers to buy more products. To further explore mitigators of opportunistic behavior, in this study, we investigate how information relevancy moderated the relationship between information consistency and fears of seller opportunism.

2 Literature Review and Hypotheses

Information consistency is the extent to which the information a person possesses about a product or website service is consistent with that of another person [7]. With the popularity of the online social community, consumers have become accustomed to read others' shopping experience. If the product-related information is consistent with the opinions of other consumers, consumers will be likely to associate this information with high credibility, because consistent information signals credibility. Therefore, high levels of information consistency will lead consumers to make inferences about product quality. Conversely, inconsistent information signals uncertainty and increases their psychological risk perception. Therefore,

Hypothesis 1: The higher level of information consistency, the lower consumer's degree of fears of seller opportunism.

Fears of seller opportunism are defined as the buyer's concerns that the seller may act opportunistically [4]. Previous studies defined opportunism as self-interest seeking with guile, including misleading, distorting, disguising, obfuscating, and so forth [10]. The main purpose of sellers' opportunism is to serve self-interest and attempt to maximize economic benefits whenever possible. Online consumers have developed effective online social cues to avoid sellers' opportunistic behavior. For example, consumers relied on online reviews to gain enough information of product for their decision. Consistent information helps them to verify that sellers did not engage in opportunistic behavior, and consumers' risk perception will be mitigated. Hence, we expect that:

Hypothesis 2: The relationship between information consistency and perceived risk is mediated by fears of seller opportunism.

Information relevancy is defined as the degree to which the product content is relevant to the content of the webpage in which it is embedded [11]. When online consumers are aware that the online information is relevant to their targets, they are more likely to scrutinize the consistent information. The information can be elaborated via the central route of cognitive processing, which in turn leads to making decisions with more confidence, thus reducing fears of seller opportunism. In contrast, if consumers are engaged in low level of relevancy, they will lack motivation to exert cognitive effort to scrutinize consistent information. Therefore,

Hypothesis 3: There is an interaction between information relevancy and information consistency on fears of seller opportunism. The effect of information consistency will be magnified under higher level of relevancy.

3 Methodology

3.1 Data Collection

Undergraduate and graduate college students were targeted as study participants because this age group is representative of frequent website users. Participants were actual buyers who have had at least three real transaction experiences purchasing products on the Taobao website (the largest online shopping platform in China). This targeted sample of online consumers helped ensure that we had respondents who were familiar with the transaction process on the Taobao website. To test the proposed research model, a questionnaire was distributed in the colleges of China. To motivate participation, compensation by way of RMB 30 (about USD 5) was given to each participant. A RMB 200 cash lottery was offered as an incentive.

3.2 Measurement

All the constructs and items were adopted from prior relevant studies. Slight wording modifications were made to them to fit the context of this study, and all measures used a 7-point scale. Specifically, to measure information consistency, respondents were asked to rate four statements developed by previous studies [7]. Four validated measures were adapted from previous studies to measure fears of seller opportunism [4]. Information relevancy was measured by five items adopted from previous study [11]. To measure perceived risk, respondents were asked to rate four statements [6]. To improve the internal validity of the study, control variables such as, demographic information, age, gender, and income were controlled.

4 Results

In total, 240 responses were received. After careful scrutiny of the data, 12 responses with either over 30% blank answers or many identical answers were dropped.

As indicated, 40.4% of the participants were male, and the majority (65.8%) were between 20 and 25 years old. As for frequency of online shopping, 50.9% of the participants had purchased at least ten items online during the preceding year. 85.5% of the participants had two or more years of online shopping experience.

Results presented in Table 1 were summary statistics and intercorrelation for the measured variables. We found significant negative correlations between information consistency and fears of seller opportunism. Thus, Hypotheses 1 was supported.

We used the bootstrapping procedure to test the mediating effect, we applied the PROCESS macro of SPSS developed by Hayes (2015) [12]. Using bootrapping with 5,000 resample, we found that the indirect effect for the link between information consistency and fears of seller opportunism and risk was negative (-.028), with 95% confidence intervals CI = [−.0581, −.0070]. The results of bootstrapping showed that the mediating effects of fears of seller opportunism was significant. Thus, Hypotheses 2 was supported.

Table 1. Descriptive statistics of and correlations among variables

	SD	1	2	3	4	5	6
1. Gender	0.492						
2. Age	0.499	(0.094)					
3. Income	0.557	0.073	0.114				
4. Relevancy	1.181	0.095	0.075	(0.045)			
5. Consistency	0.993	−.185**	0.121	0.065	(0.003)		
6. Opportunism	1.137	(0.113)	(0.003)	(0.002)	(0.065)	−.180**	
7. Risks	.6767	.106	−.029	.017	−.011	−.243**	.226**

Note. N = 228 *$p < .05$, ** $p < .01$, *** $p < .001$.

5 Discussion

The current study investigates the effects of certain factors on the reduction of sellers' opportunistic behaviors. This study has several important implications for research.

First, this research proposes that online social information is important and effective on reducing sellers' opportunistic behavior. The existing research mainly focus on other factors, including suspicion or lack of trust and individual-level dispositional factors [8]. These factors are out of the control of e-commerce practitioners. This research proposes that online information (e.g., relevancy and consistency) will lead to less fears of seller opportunism. This study fills the research gap by extending the effects of online social information on reducing seller opportunism behavior.

Second, the finding implies that the more consumers are exposed to information consistency, the lower their degree of risk perception, this relationship was mediated by fears of seller opportunism. Consistent with previous research that fears of seller opportunism produce additional costs on online transactions, increasing consumers' risk perception [2, 8]. Information consistency helps consumers verify that sellers did not engage in opportunistic behavior, and their risk perception will be mitigated.

Thirdly, by examining the moderating role of information relevancy, this study extends the significance of online social information by integrating them within the context of different relevant level. Because the effect of information consistency rarely occurred in isolation in the online environment, it depends on other factors (e.g., relevancy). This study provides evidence that the relationship between consistency and fears of seller opportunism is magnified under higher level of information relevancy conditions. This study makes contribution by show that not only what kind of information should be presented, but also how the information should be organized on the website to reduce fears of seller opportunism.

Practically, the rapid IT technology renders sellers engage in opportunistic behaviors with low cost. This study provides guidelines for practitioners' efforts to mitigate sellers' opportunistic behaviors in the e-commerce [3]. First, the findings of this study encourage practitioners to pay attention to the influence of information consistency on reducing online sellers' opportunistic behavior. Consistent information in online social community

signals higher level of credibility, Secondly, current results will benefit practitioners from the point that when delivering relevant information to customers, they also need to consider how to match other online information appropriately. To maximize business opportunities, online practitioners should more sensitive to the processing information relevancy.

6 Limitations and Future Study

The findings of this study need to be considered in light of its limitations, which indicate interesting and fruitful future directions.

First, because the sample of this study was obtained from China, the subjects are mainly college students, its demographic generalization will be limited as online consumers. Future research could extend and validate this study by collecting more samples or conducting research in a different e-commerce context. Future studies should use a longitudinal design to enable an examination of the effects of fears of seller opportunism. Second, this research proposes that two type of online information (e.g., consistency and relevancy) are effective in reducing sellers' opportunistic behavior. Future research could attempt to explore other online information in reducing sellers' opportunistic behavior. For example, it would be interesting to test whether good record reputation, transparent payment and delivery processes will lead to less fears of seller opportunism.

Acknowledgments. This research was supported by the grants from the National Natural Science Foundation of China (No. 71601168; 71172113).

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Conceptualizing Opportunities and Challenges Relevant to the Inclusion of Humanoid Service Robots in the Context of COVID-19

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Abstract. The COVID-19 pandemic has heightened the need for a better understanding of how service robots (SR) can aid practitioners as well as society. Individuals must not only embrace the robotic environment but also learn how to collaborate with humanoid service robots for collective value creation. Starting with the eminence of humanoid SR in the context of the COVID-19 pandemic, we majorly focus on anthropomorphism and social exclusion. These two key concepts present both opportunities and challenges, being the most eminent areas of research in the quest for understanding society-robot relationships.

Keywords: Robots · Humanoid service robots · Services · Service robots · SR · COVID-19 · Anthropomorphism · Social exclusion

1 Introduction

The COVID-19 pandemic accelerated many businesses' digitalization, particularly for frontline services where employing humanoids reduces risks for human actors that cannot distance socially during the encounters. Humanoids, also known as anthropomorphic robots, prove advantageous in adapting to humans' physical spaces with their human-like forms, sizes, and motions. Service robots (SR) have long been deployed for socially-assisting the elderly, in dining and catering services, and even for sexual pleasure. As time with robots passed, several entrepreneurs took on the role of warning against uncontrolled artificial intelligence and the use of robots largely for defense purposes. Thus, individual and societal emotions towards robots turned from excitement and empathy towards anger and fear [1]. As humanoid SR's deployment in service provision unfolds, there is also a heated debate across business circles on whether COVID-19 speeds up robots' use to replace human workers [2]. Some believe that robots help the world resume 'normal life' faster at the cost of their potential contribution to already high unemployment levels [3]. In short, the rise of SR can be conceptualized as a double-edged sword with buzz and engagement on the one hand versus eeriness [2].

Yet, the inclusion of humanoid SR in providing numerous services and its effects remain as emerging fields of research, mainly as it unfolded in the context of COVID-19.

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 153–158, 2022.
https://doi.org/10.1007/978-3-030-85540-6_20

As a response to the COVID-19 challenges in unavoidable indoor proximity settings, many services replaced their touchpoint staff with robots, such as delivering medical and vital supplies and samples across hospitals, collecting patient information from those with possible exposure to the SARS-Cov-2 virus [4], contactless services at hotels such as check-in and various contactless payment mechanisms.

We aim to contribute to the ongoing research efforts on the inclusion of robots in services by focusing mainly on humanoid robots, which have globally received attention in the context of COVID-19. First, the eminence of SR as well as the context of the COVID-19 pandemic and relevant conditions are introduced briefly. Then, we discuss a number of challenges and opportunities related with SR in the context of the COVID-19 pandemic. Among those, first anthropomorphism is discussed conceptually, and a list of related empirical findings are presented. As anthropomorphic SR are being introduced as social entities in an accelerated pace, both the level of anthropomorphism and humanoid interaction's kind and type can influence overall attitudes towards robots [5]. Both opportunities and challenges related to the anthropomorphic SR are discussed.

This is followed by a discussion of the anthropomorphic-robots and human relationships from a social exclusion perspective. Compared to social distancing and the functionality of SR, individual social exclusion and its impact on both micro and macro levels on SR acceptance is relatively ignored. Even though we provide a glimpse of a theoretical as well as practical discussion, the short-and long-term effects of a worldwide social exclusion (such as the one experienced during the COVID-19 pandemic) are unknown.

2 Service Robots (SR) and the COVID-19 Pandemic

Service robots (SR) are defined as robots possessing a certain degree of autonomy as they perform personal or professional tasks for humans [6]. Their capabilities in registering habits and attitudes of the humans that they interact with are known to affect the perception of intimacy, privacy, bonding, and emotional support in those individuals [7–9]. In addition to looking and moving like humans, recent technological progress also equips SR with human-like learning and creating abilities [10–12].

The COVID-19 outbreak accelerated the adoption of SR. They offer contact-free reliable performance in various tasks such as contactless delivery of food and medications, disinfecting, patrolling non-pharmaceutical social interventions, and assisting in reception [13, 14]. SR proved particularly helpful in supporting the healthcare services that struggled to cope with increasing demand [15–17]. On the other hand, SR are also a source of concern during the pandemic with already rising unemployment figures. They can replace human workers by serving drinks and food to customers in hotels and airport lounges [18] or handling check-in and check-out services at hotels [19]. Recent research already reported the preference for robot-staffed hotels when COVID-19 is salient [20].

As the marketplace and various servicescapes rely more and more on technological assistance such as SR and AI, related discussions of human-humanoid relationship should weigh both opportunities and challenges of the phenomena.

3 The Anthropomorphism – Opportunities and Challenges

Anthropomorphism is "the tendency to imbue the real or imagined behavior of nonhuman agents with humanlike characteristics, motivations, intentions, or emotions" [21]. It is an inductive inference mechanism whereby individuals assign distinct human characteristics to non-humans, particularly the capacity for rationality (agency) and conscious feeling [22]. In terms of form, robots are roughly classified in three forms: anthropomorphic (human-like), zoomorphic (animal-like), or machinelike [23]. Later on, robots were classified in more detail on a continuum of human-like / animate dimensions such as physical versus virtual, humanoid versus non-humanoid. Non-physical robot entities can be holographs, videos, voicebots, textbots or software bots. Anthropomorphizing robots is performed based on factors such as voice [24], facial features [25] and ability to take the listener's perspective [26].

With the increasing rates of social isolation and virtual immersions in non-animate worlds during the COVID-19 pandemic, the need for research to understand human perceptions of anthropomorphic robots is way imminent than ever.

Anthropomorphic SR are donated with more opportunities compared to machine-like robots in terms of functions but more importantly in terms of acceptance and attitudes of human beings. Degree of anthropomorphic representation is an essential determinant of both how a person acts towards them or how a person should respond in relation to or in the existence of them. For example, anthropomorphic virtual assistants are shown to enhance users learning in software programs by dealing with knowledge overload better [27]. Anthropomorphic faces and voices in the interface of a survival task made individuals feel better understood [28]. Waytz, Heafner and Epley [22] demonstrated that individuals perceived an autonomous vehicle more competently as it acquired more anthropomorphic features such as being named, gendered, and voiced. Moreover, participants trusted their anthropomorphized vehicle more, were more relaxed in an accident, and blamed their vehicle and related entities less for an accident caused by another driver. Anthropomorphism enhances the demand of buyers for goods with a superior beauty by the stereotype of "beautiful is good" [29].

On the other hand, there are numerous challenges that come with an anthropomorphized SR. Primarily, the theory of uncanny valley drives these challenges. An influential theory, the Uncanny Valley by Mori [30], states that as the presence and behavior of a robot are made more human, the emotional response of individuals will become more optimistic and empathic - until a point is reached at which a reaction of revulsion will arise. Accordingly, as robots become more similar to humans, humans increasingly tend to avoid them. Among many examples, individuals do not choose to cooperate and work with serious-looking anthropomorphic robots [31]. Moreover, robots with wheels, treads or squared edges cannot be anthropomorphized as easily [32], and thus not lead to desired outcomes as in other anthropomorphic robots.

Anthropomorphic robots present enormous opportunities following the endured social exclusion periods of human beings during the COVID-19 pandemic, too. Literature shows that anthropomorphic entities, who can provide genuine human interactions, partially mitigate many negative and unwanted effects of social exclusion. Anthropomorphic entities (i.e., robots) can satisfy the social assurance needs of individuals, in the absence of other real human entities and reduce the need for socially close others in

the near future [33]. Social needs and exclusion are discussed in more detail in the next section in the context of humanoid SR deployment during the pandemic.

4 The Social Exclusion – Opportunities and Challenges

The social distancing recommended during the COVID-19 pandemic resulted in a more severe exclusion of some members of the societies based on physical social contact. As some of these vulnerable groups involved older adults and persons with disabilities who were already falling into the digital divide's cracks even before the pandemic, they faced exclusion from digital services that aimed to compensate for the lack of physical contact [34]. All around the World, even in well-developed countries with progressive digital societies, such groups struggled with the double burden of social and digital exclusion.

As psychological distress, social exclusion emerged as an additional challenge to be tackled amid the pandemic [35]. As a humanoid robot introduced in 2016, Sophia the robot [36] assumed a new task towards this challenge by following its producer Hanson Robotics' decision to mass-produce thousands of robots by the end of 2021. The idea was built on taking Sophia as the foundation character and generating spin-offs to enhance human-to-machine empathy and compassion in the healthcare sector. The robot Sophia, "capable of measuring temperature with its thermal camera on her chest or leading morning exercise for the older adults, it aimed to help take care of sick and elderly. It was also useful in helping to communicate, giving therapy, and providing social stimulation even in difficult situations" [36]. As such humanoid SR emulated the human form, figure, and interaction, it was believed that they might also help with the loneliness felt due to the social exclusion. The aimed delivery of human warmth through telepresence or autonomous extension of human expertise offered both an opportunity and a challenge in touching the hearts of the people by positioning SR as our true friends.

5 Conclusion

Acceptance towards humanoid SR during the COVID-19 pandemic accelerated, yet the challenges persist despite the involved opportunities. The emerging social technological acceptance demands further research for improved policymaking that can facilitate better affordances and readiness.

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Implementing "SIREKAP" Application Based on Election for Improving the Integrity of Election Administrators and Increasing Public Trust

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Abstract. The application of ICT development does not occur in administering governance administratively and in political administration in general election techniques. This study aims to elaborate on using information technology in implementing the 2020 Election for governors, regents, mayors in Indonesia, which was held in 270 regions. This research method used a qualitative descriptive method. This study's findings are that the use of SIREKAP has benefits in maintaining the principles of transparency and integrity of election administrators. Using ICT in general elections plays a role in improving the integrity of election administrators and increasing public trust in the election results. The Indonesian General Election Commission (KPU) made innovations through the SIREKAP (Recapitulation Information System) application, a form of transparency in the implementation of vote counting and recapitulation of vote count results which are carried out in stages starting from the TPS level to the Regency/City/Provincial KPU.

Keywords: Election · E-Government · SIREKAP

1 Introduction

In practice, ICT has started to play an essential role in all areas of human life, including the political process, the mechanism of participation in elections, provision of legitimacy, technological solutions, and efficient application in the e-voting process [1]. One of the essential tools used in political and administrative settings is applying applications, where ICT tools are used to facilitate the voting process for representative elections and decision making [2]. The world's democratic countries will benefit from developing a safe election application system to increase voter participation and trust and prevent election fraud [3]. Election implementation supported by electronic applications provides accuracy and efficiency in the election process [4].

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 159–165, 2022.
https://doi.org/10.1007/978-3-030-85540-6_21

Elections around the world are going digital, governments are starting to adopt regulations to regulate the use of technology in the election process, playing a role in protecting the integrity of elections [5]. As the fourth most populous country globally, Indonesia has national presidential and vice-presidential elections held every five years in Indonesia; the method used in Indonesia's elections is voting conducted by the General Election Commission (KPU) [6]. General elections in Indonesia are held simultaneously in 2020, and the KPU (Indonesian General Election Commission) is making digital innovations in increasing the quality of elections. This innovation was carried out by applying the SIREKAP application (recapitulation information system) (Kompas, 2019). The application of Sirekap has been regulated in several KPU Regulations (PKPU), including the latest revisions such as PKPU Number 18 of 2020 and PKPU Number 19 of 2020 (Tirto, 2020).

Applying applications in a free, transparent and fair electoral system is essential to correct fraud in the old electoral system [7]. The increasing use of technology, especially in online data storage with cloud systems, has made data security one of the essential needs for users [8]. Implementing the ideal e-voting system will allow users to go online, use a web browser or phone application, enter their credentials and votes to create the effectiveness and accountability of the election administration [9]. The implementation of the use of application systems in general elections carried out in Jordan uses an established e-government adoption model and a theoretical framework consisting of the diffusion of innovation (DOI) theory and the technology acceptance model (TAM) [3]. However, such an application's integrity and the image will not be preserved unless security and authenticity measures are strictly implemented in realizing the implementation of free and fair elections [10].

This research focuses on applying ICT development in the SIREKAP application model in election in Indonesia in 2020. Also, two questions will be answered in this study. Democracy as a whole. Q2: How the application of SIREKAP can increase public trust in the election result.

2 Literature Review

As elections worldwide go digital, governments are starting to adopt regulations to regulate the use of voting technology and protect the integrity of elections (Essex & Goodman, 2020). The world's democracies will benefit from using ICT in general elections, which can create security not only to increase voter participation and trust but also to prevent fraud in elections [3]. The use of applications in the general election system as a complex information-communication technology innovation can create social trust at the institutional level and political cohesion at the national level [11].

3 Method

This study focuses on looking at the function of ICT development in applying applications in general elections in Indonesia. Researchers in conducting research using a descriptive qualitative approach. This research data is implementing the SIREKAP application in the 2020 election in Indonesia, which was held in 270 regencies, cities

and provinces. Also, the analysis stage is presented descriptively in the observation findings of the SIREKAP function, then its role is seen in improving the integrity of the implementation of the election.

4 The References Section

The election process in Indonesia has progressed in its implementation using Information and Communication Technology development. The development of application-based and website-based SIREKAP service models plays an essential role in improving the quality of democracy. For the first time, the electronic vote recapitulation or SIREKAP information system is used in the 2020 election. Guidelines for using the SIREKAP application are prepared by the General Election Commission (KPU) and addressed to the General Election Commission, Provincial General Election Commission, Regency / City General Election Commission, and the organizing body. Ad hoc, to monitor the use of SIREKAP at the stage of vote counting and recapitulation of vote acquisition results (Table 1).

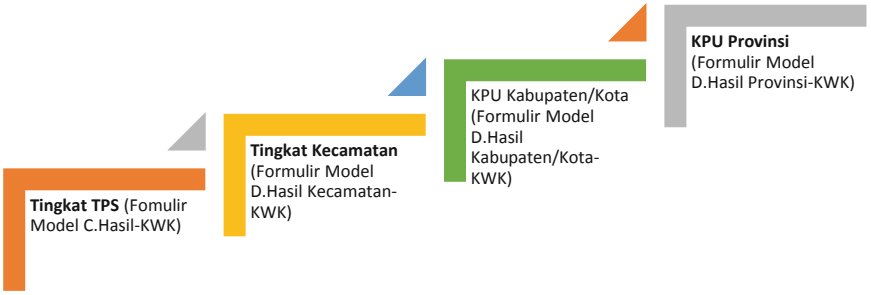
Table. 1. Comparison of SIREKAP Mobile and SIREKAP Website

SIREKAP Mobile	Doing photos, send, and checking the suitability of reading the application form C.Hasil KWK Model
	Generates digital copy C.Hasil KWK Model form to be submitted to the PPS and Regency City
	Produce the data count votes in the polling stations as publication data quick count by Regency/City KPU
SIREKAP Web	A tool for the recapitulation process of vote counting in stages at the District, Regency/City and Provincial levels;
	Monitor the recapitulation of Vote Count Results data in stages at the District, Regency/City and Provincial level
	Produce Forms Model D.Hasil Kecamatan-KWK, Model D.Hasil Kabupaten/Kota-KWK, and Model D.Hasil Provinsi-KWK
	Results Record disputes and results in dispute

The SIREKAP application in its implementation can be accessed via a smartphone and based on a website. The input process’s technical implementation is carried out via a smartphone-based on the recapitulation of votes at each voting location. Also, the SIREKAP website’s role is to verify the results of the recapitulation of vote pro-cessing at each level. Recapitulation of data on the results of election results has a recapitulation stage for data verification (Table 2).

The stages in implementing the recapitulation of data import in the SIREKAP system have four stages. In each stage, the data input is verified through the official website accessed by the KPU Commissioner. I am first reading the votes acquired at the polling station level as stated in C. Results-KWK. Second, the means to tabulate or add up the

Table 2. Classification process comparison SIREKAP



votes acquired at each level of the recapitulation. Third, the means for sending the results of the vote acquisition at every level starting from KPPS to PPK, PPK to Regency/City, to Regency / City to Provinces. Fourth, to publish the vote acquisition.

Moreover, fifth, of course, is a means of control and to cut the chain of manipulation of the vote recapitulation that occurs in stages. Also, verification of each stage is proven by a meeting of each stage's full results and agreed upon through the results of an official report. The recapitulation results in the SIREKAP system at the Election in Indonesia in 2020 were held in 270 regions that were divided into each type of election (Fig. 1).

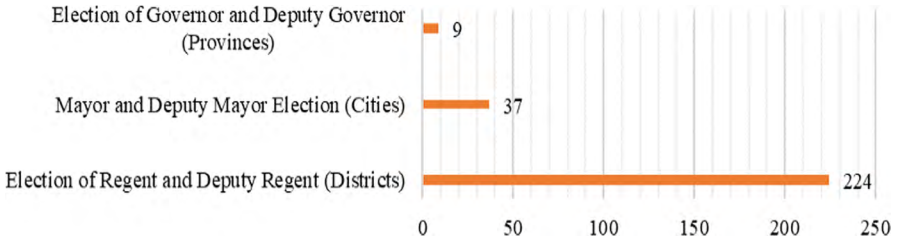


Fig. 1. Distribution of types of election of 2020 recapitulation

The implementation of elections in Indonesia is a big challenge; where the population is large and the locations are divided in a not centralized distribution, election results are often a big problem. Through SIREKAP, the recapitulation of results can be integrated and prevent fraud from election organizers. The results of SIREKAP in a position of legitimacy have official strength, where the results of the recapitulation of each stage of SIREKAP must be attached with proof of approval of the minutes of plenary meetings at each level (KPU, District, City and Provincial). The recapitulation results will automatically be included in the recapitulation big data that is integrated nationally so that the public can directly access the transparency of the 2020 Election in Indonesia.

The national recapitulation (https://pilkada2020.kpu.go.id/#/pkwkp) as a complete display of the infographic recapitulation results of the acquisition of candidate pairs in all regions. Technically, SIREKAP facilitates the public in monitoring and supervising

the progress of general elections. Also, with SIREKAP, the results of general elections can be known more quickly, where previously the public had to wait until evening, but through SIREKAP, the public can see the election results in an updated manner (Fig. 2).

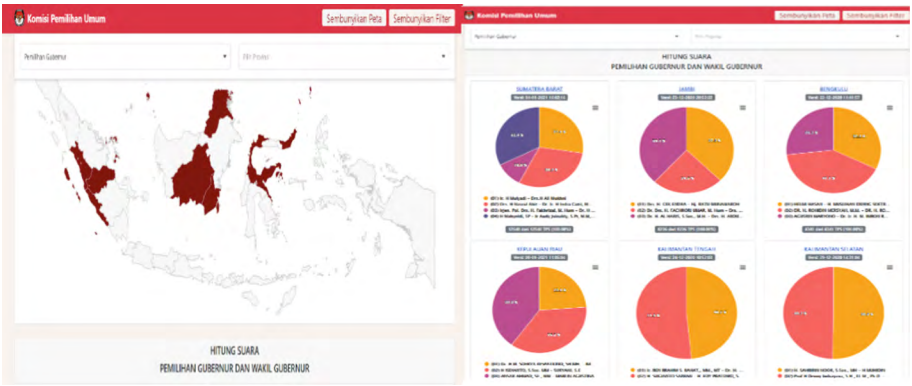


Fig. 2. National SIREKAP page

The infographic on the national recapitulation results through SIREKAP can be used as an inventory of the results of the general election digitally. Election results through SIREKAP can be easily accessed about election results at the cumulative final result level or up to the initial polling station level. The use of SIREKAP in general elections, the utilization of ICT Information Communication Technology in organizing Elections in Indonesia has excellent benefits (Table 3).

Table 3. Comparison of SIREKAP and Manual recapitulation uses

Comparison of Manual and Digital	
Recapitulation Manual	Recapitulation Digital Recapitulation
Writing the C1 form by copying the results and voting results from C Plano is more complicated than counting ballots	The Sitemap application is intended to make it easier for KPPS because all the voting results documents are written into a single form coded Model Form C. Result-KWK
KPPS officers must fill in the C1 form by hand and put a wet signature	This method is expected to prevent irregularities and manipulations in the recapitulation process
The rewriting process has the potential to make mistakes so that the numbers recorded can vary	
Manual recapitulation and the large number of C1 forms that had to be filled in often confused KPPS officers	
The differences in the numbers on the C1 Forms could have occurred due to human error to unintentional	

The SIREKAP application is different from the Counting Information System used in previous elections, which focused on publishing election results only. SIREKAP has a more significant function in the aspect of publication but functions to count votes and tiered vote recapitulation. Comparison of the old system built by the KPU using (SITUNG) the implementation stage of the C1-KWK form as the election results at the TPS was scanned (scanned) then published on the KPU's official page. The application of technology in SIREKAP uses optical character recognition (OCR) and optical mark recognition (OMR) technology where form C.Hasil-KWK at TPS are designed to be read by the system by photographing form C.Hasil-KWK via mobile phone with the Sirekap application installed so that each KPPS member must photograph the results of the manual counting of votes acquired by each pair of candidates as outlined in form C.Hasil-KWK via their respective cell phones.

Four problems must be handled in the development of the SIREKAP application. First, technology, Sirekap infrastructure such as gadgets, the readiness of human resources (HR) or ad hoc election organizers, in this case, polling group officials (KPPS), and most importantly, the legal framework. According to Heroik, the use of technology in elections must be well prepared, inclusive, and with sufficient time.

5 Conclusion

The use of the SIREKAP application in the 2020 elections in Indonesia has had a significant impact. The application of ICT in general elections can be used as election administration to improve election quality principles (accountability, transparency and fairness). Also, the development of ICT in general elections can be a solution related to fraud prevention.

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The Effectiveness of Social Resilience in Indonesia

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Abstract. This study aims to determine the effect of social media, in this case, Twitter, on social resilience effectiveness during a pandemic and explore the distribution of COVID-19 assistance funds and analyze the effectiveness of implementing government assistance to the community. A qualitative descriptive research method was used with NVivo 12 Plus software. The results showed that Twitter was a transparent medium for organizing social assistance from the Ministry of Social Affairs. From the four indicators, the indicators for the monitoring program were still lacking. There is still a need for improvement in program monitoring while the other indicators are excellent. The effectiveness of social assistance during the pandemic through Twitter is adequate.

Keywords: Social resilience · COVID-19 · Social Media · Government · Indonesia

1 Introduction

The pandemic that first appeared in the City of Wuhan, China, has had a significant impact on the economies of countries in the world, including Indonesia, where the global economy will slow down and significantly affect the industrial world, resulting in many workers being laid off, decreasing income and business. Businesses that experience losses even have to close their businesses [1]. The government makes various policy programs that can directly help the community. Various assistance is provided to the community in various forms, such as cash, basic foodstuffs, or cutting electricity tariff bills. People affected by the COVID-19 pandemic need helps in the hope of meeting their daily needs. This assistance's main objective is to ensure the availability of basic needs and social protection, especially for vulnerable groups affected by the COVID-19 pandemic [2]. However, since this pandemic, the government has issued special social assistance. This social assistance needs to be issued because the number of informal workers has experienced a drastic decline even to the point of losing income due to existing policies, the increasing number of vulnerable groups due to many companies

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 166–173, 2022.
https://doi.org/10.1007/978-3-030-85540-6_22

that cut off working relations with their workers [2] and a decrease in people's purchasing power to fulfill their daily needs.

In today's digital and internet era, all parties can use social media (including government agencies) to convey various information to all groups. The breadth and ease of access to social media can be utilized mainly by government agencies to convey and disseminate all kinds of information to the public [3]. As a means of communication, social media is expected to inform the public about social assistance distribution [4]. In the current situation of the COVID-19 pandemic, government agencies can take advantage of social media as a means to construct and maintain a reputation, especially those related to bureaucracy and its services to the public. [5] states that measuring the effectiveness of a program can be done by using the following variables: Program target accuracy, program socialization, program goal achievement and program monitoring.

The difference between this study and previous research is that this study focuses more on the direct influence of social media and discusses current issues in social assistance during the pandemic with the help of NVivo 12 Plus so that the resulting data opens up updates of knowledge. Previous studies primarily only analyzed public services, so this research has differences in collecting and analyzing data.

2 Literature Review

2.1 Effectiveness of Social Resilience

Effectiveness is a criterion for selecting various alternatives to be used as recommendations based on consideration of whether the recommended alternatives provide maximum results (consequences), regardless of efficiency considerations. [5] argues that effectiveness is the suitability between output and the objectives set. Similar [6] also argues that effectiveness is the relationship between output and objectives, the greater the contribution (contribution) of output to the achievement of goals, the more effective the organization, program or activity is. Effectiveness focuses on the outcome (result), program or activity that is considered effective if the resulting output can meet the expected objectives.

Determination of the objectives seen in this study the output produced from the program is the empowerment of the community which is marked by an increase in knowledge, skills and skills so that it can produce positive social change [7]. hen linked with this research, 'culture' means the PerpuSeru program aimed at the 'new society', in this case the community or program target group [8]. Program objectives Increase skills and skills, empower the community, improve the quality of life and welfare of the community, as well as the efforts & strategies used to achieve program objectives data obtained from the field obtained from the results of questionnaires and probing carried out obtained the results of the calculation of effectiveness by means of 4.06 with effective judgment. In accordance with the statement of Calyton and Petry in [9] which states that monitoring is a process of measuring, recording, collecting, processing, and communicating information to help make program management decisions. Government policies impact society, mainly due to the lockdown policy or PSBB (large-scale social restrictions). Thousands of citizens in Indonesia who work as traders, online motorcycle taxis, construction workers, odd jobs and workers with middle to lower-income have

lost their income. Therefore, the government must facilitate all their food needs as long as the government implements the lockdown policy [10].

Apart from implementing medical treatment policies, the government has also made various policy programs to help the community directly. Various assistance was provided in various forms such as cash, necessities, and electricity tariff bills discount to people affected by the COVID-19 pandemic and distributed to meet their daily needs [11]. This assistance's primary purpose is to ensure basic needs and social protection. The vulnerable group in question is uncertain workers in terms of working hours, contracts, scope and guarantees [11].

The number of laid-off workers will increase the number of vulnerable groups in Indonesia. Before the COVID-19 pandemic, vulnerable people received a lot of assistance from the government. However, since the pandemic, the government has issued special social assistance because many informal workers have experienced a drastic decline, even to the point of losing income due to existing policies. The number of vulnerable groups increases because many companies have cut off their workers and decreased people's ability to fulfill their daily needs [12].

2.2 Social Media as Socialization

Governments must act quickly to communicate crisis information effectively and efficiently to public members during times of public crises. Failure to do so will undoubtedly make people afraid, uncertain and anxious under the prevailing conditions [13]. The use of georeferenced social media data in disaster and crisis management is increasing rapidly. Particularly for floods, georeferenced images shared by residents can provide situational awareness to emergency responders and aid in financial loss assessments, providing information via conventional sensors or remote sensing products [14].

Also Reveals that: (a) Social media analysis is an efficient approach to capture public attitudes and perceptions during a pandemic; (b) Social media data collected from multiple people can guide the intervention and decisions of authorities during a pandemic; and; (c) Effective use of government social media channels can help the public to follow the measures/restrictions introduced. For the authorities to understand people's perceptions and identify the public's needs and demands in a pandemic situation, the authorities cannot carry out direct and prolonged public consultations [15]. The internet can be used for telemedicine and restoring daily routines. However, care is needed to spend excessive time searching for COVID-19 news on social media given the infodemic and emotional transmission through online social networks. Online platforms can monitor the number of victims of a pandemic on mental health [16].

3 Research Methods

This research used descriptive qualitative research. Data analysis used NVivo 12 plus software, data retrieval via the KEMENSOS RI's Twitter account via NCapture from NVivo 12 Plus with Web Chrome. The data was processed with the Crosstab feature to automatically compute the required main statistical tests with significant comparisons and indirect variables. The Crosstab Query feature was to enter code (manual, generated,

etc.), text data, and numeric data in variable and pattern data. At this stage, an automatic calculation was found among all data regarding the effectiveness of Pandemic Social Assistance's implementation. Word Tree feature was used to see patterns of relationships in discussions.

Furthermore, using the Word Cloud feature, the most frequently used words or terms could be revealed. This study investigated the effectiveness of social assistance implementation during the pandemic through Twitter, measuring indicators of participation, transparency, conversation, interaction, and communication [17].

4 Results and Discussion

In this globalization era, technology is increasingly advanced. The internet is increasingly needed in society, education, and business activities. Social media is a source of information on government policies being implemented and sharing and information with the public. Like the social assistance policy during the pandemic, the social assistance (bantuan sosial/bansos) carried out by the Ministry of Social Affairs (Kemensos) is one of the government's efforts to help residents survive the COVID-19 pandemic. Twitter is used to share information, and the Ministry of Social Affairs of the Republic of Indonesia has an account to provide information on social assistance policies. The data results show social media's influence from various indicators, called program target accuracy, program socialization, program goal achievement, and program monitoring. The results of this analysis can be seen in Fig. 1 below.

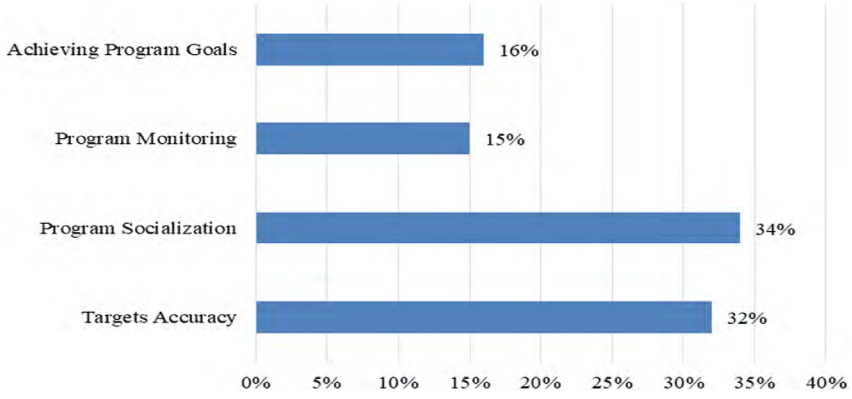


Fig. 1. The Effectiveness of Social Through Twitter Recilliensi

4.1 Accuracy of Program Targets

Determining the right goals set individually or as an organization will determine organizational activities' success. Inaccurate targets will hinder the implementation of the various activities themselves [18]. Data regarding the accuracy of program targets in

social media involvement, in this case, obtained a score of 32.00%, obtained from NVivo 12 Plus, by discussing the accuracy of the targeted policy programs being implemented. This result explains that in the indicators of target setting program results from the Twitter account of the Ministry of Social Affairs of the Republic of Indonesia December 23, 2020, Risma conveyed the relationship between the Indonesian ministry's program, including the target of complete social assistance distribution in December 2020 and then targeted distribution of social assistance in early January 2021 to move the wheels the community's economy.

4.2 Program Monitoring

Monitoring is the activity of observing the progress of implementing an activity plan, identifying and anticipating problems that arise or will arise so that action can be taken as early as possible (PP 39/2006). Monitoring is to carry out policies that are right on target, seen from the social media twitter of the Ministry of Social Affairs of the Republic of Indonesia NVivo 12 Plus obtains a score of 15%. The Twitter account of the Ministry of Social Affairs of the Republic of Indonesia has direct monitoring activities from the Ministry of Social Affairs itself. On January 7, 2021, Indonesia's president conveying to all beneficiaries of the assistance should be used appropriately and not to buy cigarettes and prioritize the family's fulfillment of basic needs. The program monitoring still needs some improvements.

4.3 Program Socialization

The learning process is done by a person (individual) to act or behave based on standards that exist and are recognized in society. Socialization is meant to incorporate cultural values into individuals to be a part of society. The government's socialization is carried out by the government through the Ministry of Social Affairs, conveying the program to be implemented through Twitter. On January 4, 2021, the government provides three types of social assistance 2021, namely the Family Hope Program (PKH), Non-Cash Food Assistance (BPNT) / Groceries Program, and Cash Social Assistance (BST). The program's socialization has been tweeted by the Ministry of Social Affairs of the Republic of Indonesia through the included link. Data analysis obtained from the account regarding Program Socialization in social assistance during the pandemic got a score of 34.00%, which means profitable. The following are the minister's Twitter account activities, which are discussed in Fig. 2 below.



Fig. 2. Social Assistance outreach program

The Indonesian Ministry of Social Affairs' Twitter account's discussion provides information and transparency regarding social assistance from the data above. The Ministry of Social Affairs socializes the program through info social hashtags and ensures that 2,512 social packages are distributed quickly. The socialization of programs from the Ministry of Social Affairs of the Republic of Indonesia by involving social media in the transparency of social assistance distribution has been outstanding.

4.4 Achieving Program Goals

By using planning, directing, organizing, and controlling resources to achieve goals effectively and efficiently, achieving goals is done. Effective means that goals can be achieved according to planning. The government provides information that provides to the public during the determination of the national emergency status of the COVID-19 pandemic. The government has issued various forms of social assistance, especially during this pandemic. This assistance is provided through various programs from each ministry. The programs include Family Hope Program (PKH), Basic Food Cards or Non-Cash Food Assistance (BPNT) and Direct Cash Assistance (BLT). The Ministry of Villages, Development of Disadvantaged Areas and Transmigration through the Village Fund provides Direct Cash Assistance to Village Funds (BLT-DD). The government issued a policy through social media for social assistance. Judging from the Ministry of Social Affairs' Twitter on January 7, 2021, after the launch of cash assistance by President Jokowi on January 4, they reviewed the distribution of PKH assistance. From the results of data analysis with NVivo 12 Plus software, the account obtained a score of 16.00% (Fig. 3).

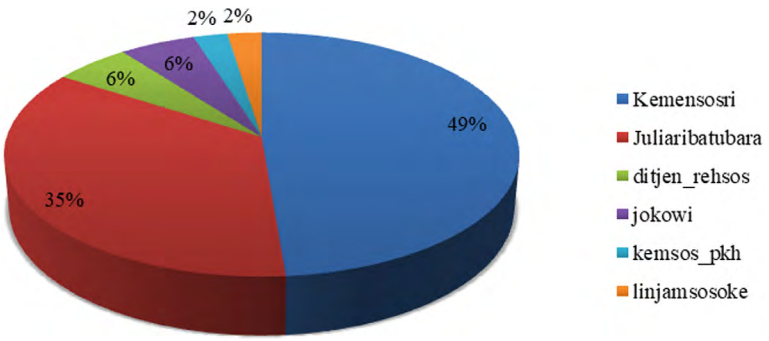


Fig. 3. Participation in the Kemensos RI Twitter Account

Based on the data above, the Ministry of Social RI's mentions part is active at the highest percentage of 49%. Various mentions provide information and mutual discussion in conveying various information to the public. The Ministry of Social Affairs often receives mentions from the Ministry of Social Affairs, Juliaribatubara, Ditjen_rehsos, Jokowi, Kemensos_pkh and Linjamsosoke. Various mentions indicate the delivery of information and policies regarding social assistance.



Fig. 4. Predominantly word using Word Cloud

Further analysis using Word Cloud is to find frequent words that are discussed in the research topic. Using Word Cloud, the types of stories that appeared on the DPR RI's Twitter account regarding social media's influence in the making of the Omnibus Law are revealed. The 100 most visible words on this topic sourced from the DPR RI Twitter account can be seen in Fig. 4 above.

5 Conclusion

Social media is internet-based media that allows users to interact and present themselves. Twitter is currently providing information about the social assistance policies made. Through the Indonesian Ministry of Social Affairs, the government has issued a policy through social media for the public to know. The Ministry of Social Affairs strives to be as effective as possible to achieve goals, from program target accuracy, program socialization, program goal achievement, and program monitoring. The results showed that Twitter is an active medium that effectively conveys social assistance information by the Ministry of Social Affairs. From the four indicators, the indicators for the monitoring program are still lacking. Program monitoring still needs to be improved, while other indicators are very good. The effectiveness of social assistance during a pandemic through Twitter is adequate. This research has limited the analysis on social media and only provided information about social assistance during a pandemic to see its current effectiveness. Future research can look for cause and effect on the low level of program monitoring through social media.

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Economic Recovery for Tourism Sector Based on Social Media Data Mining

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Abstract. The purpose of this research is to look at the Indonesian government's strategy for economic recovery in the tourism sector due to the severe impact of COVID-19. This study analyzes the Ministry of Tourism's Twitter account in promoting tourism after the COVID-19 pandemic. The method used in this study was Q-DAS (Qualitative Data Analysis). The software was Nvivo 12 plus. Stages of data analysis with Nvivo 12 plus captured data, data import, data coding, data classification, and data display. The results indicated the role of the Ministry of Tourism's Twitter account in promoting massive promotion. The Ministry of Tourism has actively promoted tourism in 2021 with various hashtags and community sentiments that are pretty positive in responding to tourism recovery due to the decline in tourism.

Keywords: Social media · Tourism · Economic

1 Introduction

According to Law number 10 of 2009 about tourism, tourist destination areas, herein referred to as tourism destinations, are geographic areas that are specific to one or more administrative areas in which there are tourism activities and are equipped with the availability of tourist attractions, public—facilities, tourism facilities, accessibility, as well as an interconnected society. Indonesia is an agricultural country with various potential natural and cultural resources. Indonesia's strategic location is a significant factor for the nation and the state's development. Such geographical conditions provide excellent opportunities for tourism development efforts. Indonesia is an archipelago country with various ethnic groups, races, cultures, communities, and tourism [1]. The decline in foreign tourist visits to Indonesia can also be seen from the data on foreign tourists who come through air entrances (airports). Compared with visits in December 2019, the number of visits to Indonesia via air entrances in January 2020. and by 2021 has declined dramatically. The decline in foreign tourists, especially to Indonesia, will affect foreign exchange earnings from tourism. Approximately, there was a decrease of USD 1.3 billion in foreign exchange earnings from tourism. China, as the country of

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 174–180, 2022.
https://doi.org/10.1007/978-3-030-85540-6_23

origin for foreign tourists, is the second-largest in Indonesia. Since the World Health Organization (WHO) explained that Coronavirus (Cov) infects the respiratory system and has spread to various parts of the world, the Indonesian economy has been affected, especially in trade and tourism. Different kinds of tours in Indonesia have been closed due to COVID-19. At the beginning of the pandemic, Indonesia considered Large-Scale Social Restrictions (PSBB) as a solution by limiting people's movement and or goods and services for virus control, as regulated in Law No. 6 2018 regarding health quarantine. The consideration is the spread of COVID-19, increasing and expanding in the number of cases and deaths, covering across regions and countries as well as affecting political, economic, social, cultural,

Based on these restrictions, tourism activities have also decreased globally. UNWTO (United National World Trading Organization) estimates that the number of international tourists in 2020 will reduce between 850 million and 1.1 billion people. The reduction is estimated to cause losses between the US $ 910 billion to the US $ 1.2 trillion UNWTO (2020). In April 2020, there was a 97% reduction in international travel with a loss range of $ 195 billion, indicating global travel restrictions to determine the spread of the pandemic impact [2].

Tourist visits from 2016 to 2019 tended to increase and in 2020 and 2021 decreased dramatically. The decline in tourist visits caused by the COVID-19 pandemic. The tourism industry is faced with a significant decline in foreign tourists' arrival with massive cancellations and decreases in bookings. The decline has also occurred due to a slowdown in domestic travel, mainly due to people's reluctance to travel, worried about the impact of COVID-19. The decrease in tourism and travel business affected MSME businesses and disrupted employment opportunities. Even though so far, tourism is a labor-intensive sector that absorbs more than 13 million workers. This figure does not include the derivative impact or the multiplier effect that follows, including the derivative industries formed under it.

In recent years the government has used social media to promote tourism. To restore tourism due to the COVID-19 pandemic's effect on the Indonesian global tourism sector, the Ministry of Tourism and Economic Creative Government promotes the existing tourism sector. During the COVID-19 pandemic, Indonesia's tourism has decreased drastically, so has its economy. In this study, how tourism is recovering in Indonesia will be revealed [3].

2 Literature Review

2.1 Indonesian Tourism During the Covid-19 Pandemic

According to the World Tourism and Travel Council (WTCC), tourism is all activities of people who travel to and live in a place outside their daily environment for no more than a year for leisure, business and others. Tourism is a social, cultural, and economic phenomenon that requires people's movement to countries or places outside their familiar environment for personal or business professionals [4]. COVID-19 is a disease outbreak that is currently spreading throughout the world, initially found in Wuhan, China. Now, COVID-19 is almost evenly distributed across all countries in the world, with many

positive cases. The World Health Organization (WHO) states that COVID-19 can cause infection in the respiratory tract with a reasonably rapid spread [5].

In previous years, the tourism sector's contribution increased, but in early 2020 the world was shaken by the COVID-19 virus outbreak. The President of Indonesia issued a large-scale social restriction instruction [5]. The COVID-19 pandemic has hurt many different tourism sectors, which in the end caused the tourism industry to close for months, even though various efforts have been made since June 2020 to reopen the tourism sector. Some managers continue to struggle, and UNWTO (2020) has recognized tourism as one of the hardest-hit industries. The crises stemming from the COVID-19 pandemic are different and unique in many ways, from the decline in travel, hospitality, and tourism worldwide [6].

Based on the Central Statistics Agency (BPS), foreign tourist visits to the country in early 2020 decreased. During January, visits by foreign tourists reached 1,290,411 visitors. This figure fell by (7.62%) compared to the number of foreign tourists in December 2019, 1,377,067 visitors. The decline in the number of foreign tourist visits was mainly due to the outbreak of COVID-19, which occurred in the last week of January 2020.

2.2 Social Media as Tourism Recovery

Social media is online media, where users can easily participate, access information, and convey ideas. Touch information technology is a phenomenon that drives change [7]. Different social media sites show the exact marketing mechanism in the marketing effectiveness model [8]. Given the critical role of social media in tourist decision-making as participants in the operations and management of many tourism [8]. Social media is online media where users can easily participate. Its development makes the potential for information dissemination even greater. Disseminating information via social media can have both advantages and disadvantages, depending on how it is used. Using social media appropriately can increase tourism interest for internet users who read and follow them [9]. The future of tourism will benefit both groups' combined experience and knowledge - practitioners and scholars [1]. Tourism destination recovery restores the image and reputation that could be affected by harmful or inaccurate media coverage [10, 11]. Social media contents have an essential role. Its content is also the key to the success of the @kemenpar account and the creative economy in managing tourism content in the region. Social media's potential has become one of the two "megatrends" with a significant impact on the tourism system [12].

2.3 Promotion, Price, Facility as Aspects of Tourism Recovery

Promotion is information regarding the advantages of the service you want to sell, so that the promotion has an impression for persuade consumers to want use the services that have been offered [13]. Price is the amount of money needed to get a certain number of goods and services or a combination of fatigue. Prices are determined by the number of requests and offers. The facility is the provision of physical equipment for provide to guests in carrying out their activities or activities -activities so that guests' needs can be met [14].

3 Method

This article used a qualitative descriptive qualitative approach to explain how the government uses social media to recover Indonesia's tourism. This study's used Twitter because the government promoted and restored tourism in Indonesia using the Ministry of Tourism and Creative Economic's (Kemenparekraf) Twitter account. The data analysis was carried out using the Nvivo 12 plus, and this research period was conducted from 2020 to 2021.

4 Result and Discussion

The government uses Twitter to promote its tourism due to the recent decline. The Ministry of Tourism and the Creative Economic is responsible for promoting tourism to return it to the normal state, and the economy can recover after the COVID-19 pandemic ends. It is also necessary to review the government's efforts to restore tourism in Indonesia in promoting tourism through social media and see the negative and positive response of the community from local or foreign tourists (Fig. 1).



Fig. 1. World frequency result (Trending Hashtags for Indonesia's tourism recovery)

From the word analysis frequency in the picture above, the most frequent hashtags are #sobatparekraf, showing that the account @ the ministry of tourism and the creative economy actively promotes tourism and creative economy in 2021 to support the recovery of the country's economy and areas where tourism is located. The other hashtags found #banggabuatanindonesia, #wonderfulindonesia, #bersamajagaindonesia, #bangkit untuk indonesiamaju. From the high magnitude of hashtags, the number which appears can be seen from the weighted percentage. #sobatparekraf has a rate of 2.41%, followed by #wonderfulindonesia with a score of 2.39%, while #bersamajagaindonesia 2% (Fig. 2).

Based on the crosstab query-rate (%) results, to recover tourism during the COVID-19 pandemic, seen through the @kementrian tourism and creative economy Twitter

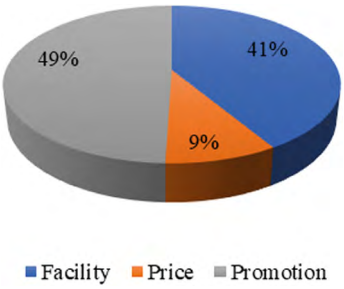


Fig. 2. Crosstab Query-rate Nvivo12 Plus (Indonesia's tourism recovery efforts)

account. The recovery is carried tourism out by promotion, improvement, facilities and price values. Advertising has the highest percentage with a discount of 49%, indicating that during the COVID-19 period, the promotion was more dominant for the recovery of tourism in Indonesia, followed by the second position of facilities with a value of 41%, indicating the effort to restore tourism. Increased facilities also have an important role and become an indicator of increasing tourist comfort during the COVID-19 pandemic. The facilities pay attention to visitor services in the Indonesian tourism sector: domestic tours and foreign tourists. Meanwhile, the price indicator is in the lowest position with a value of 9% compared to the previous hand, and in the tourism, recovery prices do not affect due to the impact of COVID-19, the economy has decreased.

The level of promotion is prioritized in the recovery of tourism in Indonesia after that, followed by an increase in facilities and value, meaning that the Ministry of Tourism and the Creative Economy's Twitter account prioritizes promotion and improvement of facilities first compared to the value of the price of a tourist attraction, which is in Indonesia (Fig. 3).

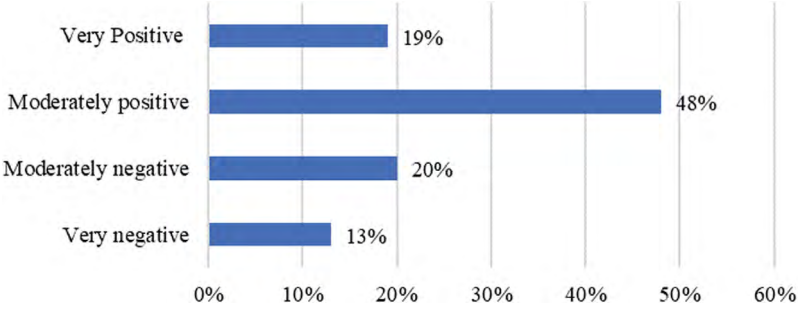


Fig. 3. Sentiment trend's domestic tourists

Based on the results of the sentiment analysis result, sentiment leads to a reasonably positive response of 48.07% in the tourism recovery program due to the impact of COVID-19, while 13.71% of the public's view is harmful in the recovery of the tourism sector. The community is supportive of the tourism recovery process to help the community and the state because tourism helps the development of the Indonesian economy,

considering that Indonesia has natural and cultural wealth with selling power or attractiveness. From the positive response of the community in tourism recovery, it is one way for tourism in Indonesia to be glimpsed by local and foreign tourists so that Indonesian tourism can recover in a fast period, so that people who are in all tourism locations in Indonesia can be directly involved in the promotion, manage and develop tourist objects that have long been a visitor crisis (Fig. 4).

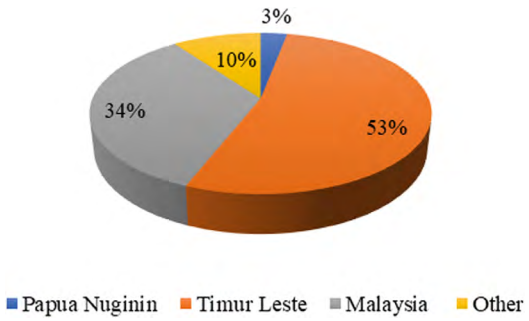


Fig. 4. Central bureau of statistics, 2021

Based on the data, 141.3 thousand foreign tourists visited in January 2021. The most came from Timor Leste, with 75.1 thousand visits (53%). The positive sentiment of the community towards the recovery of tourism in Indonesia, seen in the picture above, shows changes. In January 2020, foreign tourists were higher than in January 2021. It drastically decreased to have positive sentiments to restore the tourism sector and its economy in Indonesia. In the future, tourism can hopefully develop after the COVID-19 pandemic.

5 Conclusion

The government uses Twitter to recover tourism in Indonesia through the Ministry of Tourism and Creative Economy's account. Their account is active in promoting Indonesia's tourism to restore Indonesian tourism, seen from the various hashtags that promote Indonesian tourism, such as #sobatparekraf, #wonderfulIndonesia, #bangkituntukIndonesia, #bersamajagaindonesia, #banggabuatanindonesia. The most critical indicators to promote and improve facilities are the significant indicators to support Indonesian tourism recovery. Also, public sentiment is supportive and responds positively to tourism and economic recovery in Indonesia, including the people involved in the tourism circle.

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SHEEN: Set of Heuristics to Evaluate Mobile Applications that Interact with External Equipment

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Abstract. The heuristic evaluation is a cost-effective method that identifies usability problems with interfaces and interactive systems. In order to perform it, a set of heuristics must be selected, which can be of two types: generic or domain specific heuristics. Currently, with the dissemination of mobile devices and their applications in people's daily lives, several mobile applications that interact with external equipment have emerged, with particularities in terms of their use. The inexistence of domain-specific heuristics for this field, led us to propose our own set following the methodology proposed by Quiñones et al. to develop usability and UX heuristics for specific domains. This paper presents the application of such methodology to propose a set of heuristics suitable to evaluate mobile applications that interact with external equipment. For this, we have taken into account 3 mobile applications, and integrated 4 experiments, to improve and validate the results.

Keywords: Human Computer Interaction · Usability · User experience · Heuristic evaluation · Mobile applications · External equipment

1 Introduction

With the exponential growing number of published mobile applications in the applications stores (Google Play and Apple's App Store), along with the constant evolution of mobile phone de-sign and use, the heuristic evaluation made on these kinds of systems can sometimes be too vague or inappropriate.

Additionally, very specific products are beginning to emerge also requiring differentiated evaluations. Among the different types of applications, we are particularly interested in the ones that interact with external equipment, such as the ones allowing the users to make purchases on vending machines through their mobile phone. As with the research carried out no heuristics were found specifically designed for this purpose, therefore, we thought in proposing a set of heuristics adequate to perform a heuristic evaluation on mobile applications that interact with external equipment, hence the idea of this paper. In order to create this list, following a comprehensive reading on methods used by other authors, a methodology to develop usability and UX heuristics for specific

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 181–190, 2022.
https://doi.org/10.1007/978-3-030-85540-6_24

domains was analysed and implemented. This methodology, proposed by D. Quinõnes et al. in [1], is divided into 8 stages with their own formalities.

Section 2 of this paper describes the methodology proposed by D. Quiñones et al. to develop usability and UX heuristics for a specific domain as well as the implementation of such methodology to develop our set of heuristics. Section 3 concludes the paper and states the future work to be done.

2 Methodology

The methodology proposed by D. Quiñones et al. includes the following 8 stages: an "exploratory stage" that is composed by a literature review; an "experimental stage" to analyse data from different experiments in order to collect additional information about the domain; a "descriptive stage" to select and prioritize the most important topics of all the information that was gathered; a "correlational stage" to match the features of the specific application domain with the usability and the selected UX attributes and heuristics; a "selection stage" to keep, adapt and/or discard the collected information; a "specification stage" to formally specify the new set of usability and UX heuristics; a "validation stage" to be made upon the realization of several experiments in order to verify its effectiveness and efficiency in evaluating the specific applications, and finally a "refinement stage" to refine and improve the new set of heuristics based on the feedback from the previous experiments.

The study contained in this paper consists of an iteration of the selected methodology and all its eight phases, in order to develop a set of heuristics to evaluate mobile applications that interact with external equipment.

2.1 Exploratory Stage

Firstly, we have selected 3 applications within the specific domain in order to develop our set of domain specific heuristics: BuyOn, a mobile application that allows its users to make purchases in vending machines; MEO Go, a mobile application that allows their clients to stream into their television all the programs broadcasted in the last 7 days (from their catalog); and finally, MB WAY, an application that allows the user to access a physical ATM machine through their smartphones.

Then, a thorough investigation on the chosen used cases was done in order to collect relevant information regarding the selected domain. Additionally, some sets of heuristics were selected to aid the analysis in the following stage of the methodology: the experimental one. The chosen sets were Jakob Nielsen's 10 usability heuristics [3], some heuristics proposed by R. Miranda in her master thesis [4] and some of the ones proposed by Gómez et al. [5].

We've also selected 8 usability and 5 UX attributes that must be covered by the new set of heuristics. The usability attributes were "learnability", "efficiency", "memorability", "errors" and "satisfaction" based on Nielsen's work [6] and "user needs", "design" and "feedback" based on the R. Alturki and V. Gay [7] work. For the UX attributes, the chosen attributes were "useful", "usable", "accessible", "desirable", "findable", "credible" and "valuable", based on Peter Morville work [8].

2.2 Experimental Stage

For the experimental stage, there were no studies on usability and UX heuristics for the selected domain that could be found. Although this phase is optional according to the followed methodology, it seemed that performing an experiment would be useful in order to have a more refined list of heuristics adequate to evaluate the usability of mobile applications that interact with external equipment.

A new activity called "Discussion with specialists" was then defined and performed in order to create a preliminary list of heuristics. The general purpose of this activity was to collect ideas, opinions and reactions in relation to a particular subject or product. It is assumed that a set of participants with background in usability, interface design (UI) and user experience (UX) perform a set of tasks in order to get some feedback on the applications that serve as a case study for the experiment. This activity consisted mainly in discussing the selected applications, filling out a survey about usability and UX attributes and a questionnaire about usability and UX problems of the applications. In addition, after performing all these tasks, the limitations that the list of heuristics selected in the exploratory stage of the methodology was discussed. The output of the activity was a preliminary list of heuristics that covers all usability and UX problems encountered and that might be more adequate to evaluate mobile applications that are within the selected domain.

This whole experiment, the discussion between the participants, and its results is reported in another document [9].

The preliminary list of heuristics proposed for this stage consisted of: PHSD1[1]: Visibility of system status; PHSD2: Match between system and the real world; PHSD3: User control and freedom; PHSD4: Consistency and standards; PHSD5: Error prevention; PHSD6: Recognition rather than recall; PHSD7: Flexibility and efficiency of use; PHSD8: Aesthetic and minimalist design; PHSD9: Help users recognize, diagnose and recover from errors; PHSD10: Help and documentation; PHSD11: Pleasant and respectful interaction with the user; PHSD12: Privacy and Security; PHSD13: Interruptions; PHSD14: Waiting times; PHSD15: Focus; PHSD16: Don't lie to the user; PHSD17: Deal properly with the operating system, device type and screen orientation; PHSD18: Constant, transparent and complementary communication with the external equipment.

2.3 Descriptive Stage

For the descriptive stage, we proceeded to analyse all the collected data regarding the selected domain, the selected sets of heuristics, and finally, all the selected usability and UX attributes, prioritizing them, and discarding the information that seemed irrelevant for the development of our set of heuristics.

In the end, we were able to identify 4 aspects regarding the selected domain that seemed important to take into account in the development of our set of heuristics, 4 key and 22 specific features shared by the mobile applications belonging to this domain, 8 usability and 7 UX attributes, which are important to be evaluated with our set of heuristics, and finally 17 heuristics that could serve as the foundation for the final set to be proposed by us.

[1] PHSD – Proposed Heuristic for Specific Domain.

2.4 Correlation Stage

In the correlation stage, we matched all the collected information regarding the specific domain selected, the usability and UX attributes and the selected sets of heuristics (that remained relevant until this stage), in order to verify if they would all be connected, or if there was a need to create a new heuristic to cover any aspect of the specific domain of usability and UX attribute that wasn't included until this stage.

Therefore, in this stage, we concluded that all of them would be correlated and that there was no need to repeat any of the previous steps of the methodology.

Additionally, the methodology suggests that the heuristics can be grouped into categories based on the identified features. However, as all of our heuristics up until this moment evaluate different things, the creation of categories would generate a number of categories close to the number of heuristics, and we didn't see any advantage in creating them.

2.5 Selection Stage

Reaching this stage, there was already a preliminary set of heuristics to evaluate mobile applications that interact with external equipment, proposed after the "Discussion with specialists" experiment, which was performed in the experimental stage.

During this stage, we acknowledged that the heuristic "PHSD18: Constant, transparent and complementary communication with the external equipment" could be merged with "PHSD1: Visibility of system status", therefore the PHSD18 was discarded, and the PHSD1 was adapted to "Visibility of systems and external equipment status".

With this being said, none of the remaining heuristics from this preliminary set were proven to be inadequate, so all of them were kept for the following stages of the methodology.

2.6 Specification Stage

In the specification stage, all the proposed heuristics until now were formally specified, following the template used in [10], which consisted of the following model: *ID* – Heuristic identifier; *Priority* – how important the heuristic is: useful, important or critical; *Name* – Name of the heuristic; *Definition* – Short description of the heuristic; *Explanation* – Detailed explanation of the heuristic; *Features* – feature(s) evaluated with the heuristic; *Examples* – examples with images of inconformity or compliance with the heuristic; *Benefits* – expected usability/UX benefits when the heuristic is satisfied; Problems: anticipated problems of confusing heuristics and misunderstandings; *Verification list* – Checklist that can help the evaluators while performing a heuristic evaluation; *Usability and UX attributes related* – Attributes evaluated with the heuristic; *Set(s) of existing heuristics related* – the set on which the heuristic is based, if it exists, and the heuristic that evaluates to some degree a certain general feature or a specific feature of the applications.

2.7 Validation State

In this stage, we've performed three different experiments in order to validate the heuristics and, if relevant, collect information to be used later in order to refine the final set to be proposed.

The experiments performed consisted of: a heuristic evaluation to verify the new set of heuristics when compared to the use of a set of control heuristics, more specifically, Nielsen's heuristics, to check if the new set would be more efficient in identifying problems with the applications from the specific domain; an expert judgment to verify how adequate and valid the proposed set of heuristics is, to evaluate the applications of the specific domain; user tests for the three selected applications in order to verify if there would be any problems with the applications, identified in the tests with the users, that weren't covered/foreseen yet with the proposed set of heuristics until this moment.

For the heuristic evaluation, we asked 3 evaluators to perform a heuristic evaluation to the BuyOn application. Firstly, they performed this evaluation using the set of control heuristics (Nielsen's), and afterwards they used the proposed set of domain-specific heuristics. With all the evaluations performed, the results were analysed and consolidated in a final report, which had a total of 53 problems identified with the set of domain-specific heuristics, 9 more than the problems identified with the Nielsen ones. This allowed us to affirm that the proposed set was effective and efficient in identifying problems with the mobile applications of the specific domain.

The expert judgment activity had 3 experts in usability and UX analysing our set of heuristics, evaluating each one of the heuristics in terms of: "utility", "clarity", "ease of use" and "need for checklist" as well as making comments about them, and on how we could possibly refine our set of heuristics. In the end, the experts considered all the heuristics adequate to evaluate the applications of the intended domain, and some comments were taken into account to improve the descriptions of the heuristics. Also, this experiment allowed us to verify that the existence of a checklist for each heuristic would be helpful but not extremely necessary as all the heuristics were clear and easy enough to use.

Finally, for the user tests, we've recruited 5 participants with different ages, backgrounds, and different proficiency in terms of dealing with mobile applications, to perform a set of tasks with the use cases of this study. For each mobile application, we've selected 3 key tasks to be performed by the participants. The tests were performed next to the external equipment, therefore the context of use was taken into account for this experiment. In the end, the participants helped us identify 42 problems with the 3 applications, which were later analysed by us to verify if our set of heuristics could cover all these problems. As we were able to correctly match all the problems with at least one heuristic of our set, we concluded that our set of heuristics was indeed adequate to evaluate mobile applications that interact with external equipment.

2.8 Refinement Stage

Finally, in the refinement stage, the feedback from the previous stage was taken into account, as the experiments performed provided insightful information regarding the set

developed until this moment. This feedback resulted in a review and refinement of the specification of each heuristic.

This being said, the final set of heuristics is reported in Table 1.

Table 1. SHEEN: Set of Heuristics to evaluate mobile applications that Interact with External EquipmeNt

ID	Name	Description
SHEEN01	Visibility of system and external equipment status	The application and the external equipment should always keep users informed about what is going on, through appropriate feedback within a reasonable amount of time
SHEEN02	Match between system and the real world	The design should speak the users' language. Use words, phrases, and concepts familiar to the user, rather than internal jargon. Follow real-world conventions, making information appear in a natural and logical order
SHEEN03	User control and freedom	Users often perform actions by mistake. They need a clearly marked "emergency exit" to leave the unwanted action without having to go through an extended process
SHEEN04	Consistency and standards	Users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform and industry conventions
SHEEN05	Error prevention	Good error messages are important, but the best designs carefully prevent problems from occurring in the first place. Either eliminate error-prone conditions, or check for them and present users with a confirmation option before they commit to the action
SHEEN06	Recognition rather than recall	Minimize the user's memory load by making elements, actions, and options visible. The user should not have to remember information from one part of the interface to another. Information required to use the design (e.g., field labels or menu items) should be visible or easily retrievable when needed

(*continued*)

Table 1. (*continued*)

ID	Name	Description
SHEEN07	Flexibility and efficiency of use	Shortcuts — hidden from novice users — may speed up the interaction for the expert user such that the design can cater to both inexperienced and experienced users. Allow users to tailor frequent actions
SHEEN08	Aesthetic and minimalist design	Interfaces should not contain information which is irrelevant or rarely needed. Every extra unit of information in an interface competes with the relevant units of information and diminishes their relative visibility
SHEEN09	Help users recognize, diagnose and recover from errors	Error messages should be expressed in plain language (no error codes), precisely indicate the problem, and constructively suggest a solution
SHEEN10	Help and documentation	It's best if the system doesn't need any additional explanation. However, it may be necessary to provide documentation to help users understand how to complete their tasks
SHEEN11	Pleasant and respectful interaction with the user	The system should provide a pleasant interaction for the user so that he/she does not feel uncomfortable when using the application. This interaction can take into account, for example, the partial completion of specific form fields or make it possible to record the status of a form with many fields already filled in
SHEEN12	Privacy and Security	User data must be protected, the system must be secure and offer the user an experience that leaves him/her rested and confident that his/her personal data will not be used for other purposes or accessed or provided to other entities. The use of biometric data for authentication should be promoted, as it offers extra security and protection to the user

(*continued*)

Table 1. (*continued*)

ID	Name	Description
SHEEN13	Interruptions	The application must allow system interruptions (receiving calls, receiving notifications from other applications, switching between applications,…) without any complications for the user. The user must find the application in question in the state it was left in, so that he/she can continue using it without problems
SHEEN14	Waiting times	Long waiting times should be avoided when performing tasks. The time for the interaction should be reduced as much as possible
SHEEN15	Focus	On mobile devices, reading and understanding complex texts is relatively more complicated than in other types of devices (such as a computer), as the screen size is smaller and the content to be displayed at a time is limited. It is possible that the user may take longer to process information, which ends up causing him to lose total concentration on the application. It should be borne in mind that the user must always be focused on the main content of the application
SHEEN16	Don't lie to the user	Wrong or misleading links/buttons must be eliminated, there should be no reference to missing information. Users assume that the transmitted information (or messages) is always true. If that's not the case, it can have a major impact on the entire user experience causing the user to feel frustrated, what can lead him/her to stop using the product/application or look for other alternatives

(*continued*)

Table 1. (*continued*)

ID	Name	Description
SHEEN17	Deal properly with the operating system, device type and screen orientation	The system must follow the specific guidelines to the operating systems (Android, iOS,…) and take into account the ergonomics of the type of device it runs on (smartphone or tablet). In addition, account should be taken of changing the orientation of the device's screen from portrait to landscape mode, or vice versa, ensuring that the content appears in the correct locations and that it does not appear cut or covered

3 Conclusions and Future Work

In conclusion, we consider that using domain specific heuristics when performing heuristic evaluations can be extremely relevant to find domain specific problems with the interfaces. Also, the methodology proposed by D. Quiñones et al., was very helpful to develop our own set of usability and UX heuristics to evaluate the specific domain of mobile applications that interact with external equipment.

By conducting all the stages of the methodology, we were able to propose, validate through several experiments with both users and experts, and achieve the final list of 17 heuristics described in this paper.

To note that most of the investigation was conducted during the Covid-19 pandemic, which caused some experiments to be adapted due to all the public health regulations of Portugal in mind. Therefore, as future work, we intend to iterate the methodology again, and perform some of its stages, with new experiments and new use cases.

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Differential Non-autonomous Representation of the Integrative Activity of a Neural Population by a Bilinear Second-Order Model with Delay

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Abstract. For neuromorphic processes specified by the behavior of a local neural population (for example, processes induced by a "brain-machine" interface platform of the Neuralink type), we study the solvability of the problem of the existence of a differential realization of these processes in the class of bilinear nonstationary ordinary differential equations of the second order (with delay) in a separable Hilbert space. This formulation belongs to the type of inverse problems for an additive combination of nonstationary linear and bilinear operators of evolutionary equations in an infinite-dimensional Hilbert space. The metalanguage of the theory being developed is the constructions of tensor products of Hilbert spaces, orthocomplemented lattice structures, the functional means of the nonlinear Rayleigh-Ritz operator, and the principle of maximum entropy. It is shown that the property of sublinearity of this operator permits one to obtain conditions for the existence of such differential realizations; concurrently, metric conditions of the continuity of the projectivization of this operator are substantiated with the calculation of the fundamental group of its compact image. This work was financially supported by the Russian Foundation for Basic Research (project no. 19-01-00301).

Keywords: Inverse problems of nonlinear neuromorphic dynamics · Tensor analysis · Bilinear non-autonomous differential realization of the second order with delay · The Rayleigh-Ritz entropy operator

1 Introduction

Multidimensional neurodynamic models of synapse state evolution, changes in the rate of neural impulses, etc. in local populations of neurons [1] can take the form of systems of integral-differential equations [2]. For this differential representation of neuromorphic processes, the problem of solvability of such infinite systems is relevant. In this connection, various techniques of modern functional analysis are used, including comparison theorems, monotone iterative methods, truncation methods, and fixed-point topological methods. Another neurodynamic approach describes neuroprocesses in terms of a

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 191–199, 2022.
https://doi.org/10.1007/978-3-030-85540-6_25

"*black box*" neural network protomodel with further implementation [3] of these processes in the class of infinite-dimensional differential models [4] with and without delay. Nonlinear non-autonomous differential equations in infinite-dimensional Hilbert spaces are very productive in theoretical and applied problems of mathematical neuroscience. At the same time, the factors of non-stationarity, multilinearity, and delay of such differential models, including those of higher orders [5], reflect the integrative process of rearrangement of physical and chemical relationships in the synergetic synapse/receptor complexes [6] of the studied neural populations.

2 Dictionary of Terms and Problem Statement

Further, $(X, ||\cdot||_X)$, $(Y, ||\cdot||_Y)$ are real separable Hilbert spaces (i.e., norms satisfy "the condition of a parallelogram" [7, p. 162]); however, below, using [7, c. 176] a linear isometry (which preserves the norm) $E : Y \to X$ of spaces Y and X. As usual, $L\left(B', B''\right)$ is the Banach space (with the operator norm) of all linear continuous operators for two Banach spaces B' and B'', $L\left(X^2, X\right)$ is the space of all continuous bilinear mappings of the Cartesian square $X \times X$ in the space X, below we actively use a linear isometry [7, c. 650] of spaces $L\left(X^2, X\right)$ and $L(X, L(X, X))$.

Let $T := [t_0, t_1]$ denote the segment of the numerical line R with the Lebesgue measure μ, and let $\wp_\mu$ denote the σ - algebra of all μ - measurable subsets of T, the notation $S \underset{\text{mod } \mu}{\subseteq} Q$ $(S, Q \in \wp_\mu)$ means $\mu(S \backslash Q) = 0$. Moreover, we assume that $AC^1(T, X)$ is the set of all functions $\varphi : T \to X$ whose first derivative is an absolutely continuous function (with respect to the measure μ) on the interval T.

If below $(B, ||\cdot||)$ – Banach space, then by $L_p(T, B), p \in [1, \infty)$ we denote the Banach space of μ -equivalence classes of Bochner integrable [8] mappings $f : T \to B$ with the norm $\left(\int_T ||f(\tau)||^p \mu(d\tau)\right)^{1/p} < \infty$, respectively, by $L_\infty(T, B)$ we denote – Banach space of these classes with the norm ess $\sup_T ||f|| < \infty$ and agree that

$$L_2 := L_2(T,\ L(X, X)) \times L_2(T,\ L(X, X)) \times L_2(T,\ L(Y, X))$$

$$\times\ L_2\left(T, L\left(X^2, X\right)\right) \times L_2\left(T, L\left(X^2, X\right)\right) \times L_2\left(T, L\left(X^2, X\right)\right)$$
$$\times\ L_2\left(T, L\left(X^2, X\right)\right) \times L_2\left(T, L\left(X^2, X\right)\right),$$

$$L^* := L(X, X) \times L(X, X) \times L(Y, X) \times L\left(X^2, X\right) \times L\left(X^2, X\right)$$
$$\times\ L\left(X^2, X\right) \times L\left(X^2, X\right) \times L\left(X^2, X\right).$$

Further, we believe that on a time interval T the behavior of the studied (simulated) local neural population is registered *a posteriori* in the form of a non-power-limited nonlinear bundle N of observed neural processes in the state space X presented as pairs (x, u) of vector functions of a "*reaction*, *effect*" type, i.e. a neuromorphic behavioral system in the form of an N - "*black box*", or formally:

$$N \subset \left\{(x, u) : x \in AC^1(T, X),\ u \in L_2(T, Y)\right\}, \text{Card} N \leq exp\aleph_0.$$

Let us consider the problem: for a fixed pair $\left(N, \hat{A}\right)$, determine the necessary and sufficient conditions expressed in terms of a nonlinear bundle of dynamical processes N and an operator function $\hat{A}$ for the existence of an ordered set of eight operator functions

$$(A_1, A_0, B,\ D_1, D_2, D_3, D_4, D_5) \in L_2,$$

for which a second-order bilinear differential realization (BDR) with delay $\overline{\tau} = \text{const} \geq 0$ is implementable, having an analytical representation of the form:

$$\begin{aligned} &\hat{A}\ddot{x} + A_1\dot{x} + A_0 x \\ &= Bu + D_1(x, x) + D_2(x, \dot{x}) + D_3(\dot{x}, \dot{x}) \\ &+D_4(E(u), y) + D_5(E(u), \dot{y}),\ \forall (x, u) \in N, \end{aligned} \tag{1}$$

$$t \mapsto y(t) := \begin{cases} x(t - \overline{\tau}),\ \text{if } t_0 + \overline{\tau} \leq t \leq t_1; \\ 0 \in X,\ \text{if } t_0 \leq t < t_0 + \overline{\tau}. \end{cases} \tag{1*}$$

We agree that if the simulated operators of the BDR system (1)-(1*) are supposed to be found in the class *of stationary* ones, then we will construct them in the class *of continuous* ones, and at the same time write.

$$(A_1, A_0, B,\ D_1, D_2, D_3, D_4, D_5) \in L^*.$$

3 A Characteristic Feature of the BDR Model

We now describe an analytical scheme for solving the problem of solvability (or unsolvability) of the BDR problem (1)–(1*). So, let $Z := X \otimes X$ be the Hilbert tensor product [9] of Hilbert spaces X and X with the cross-norm $||\cdot||_Z$ defined by the scalar product [8] in X. In addition, we introduce new notation:

$$\begin{aligned} &U := X \times X \times Y \times Z \times Z \times Z \times Z \times Z, \\ &\qquad ||(\cdot, \cdot, \cdot, \cdot, \cdot, \cdot, \cdot, \cdot)||_U := (||\cdot||_X^2 + ||\cdot||_X^2 + ||\cdot||_Y^2 + ||\cdot||_Z^2 \\ &+||\cdot||_Z^2 + ||\cdot||_Z^2 + ||\cdot||_Z^2 + ||\cdot||_Z^2)^{1/2}; \\ &L_2 := L_2(T, L(X, X)) \times L_2(T, L(X, X)) \times L_2(T, L(Y, X)), \\ &\times L_2(T, L(Z, X)) \times L_2(T, L(Z, X)) \times L_2(T, L(Z, X)) \times L_2(T, L(Z, X)) \\ &\times L_2(T, L(Z, X)); \end{aligned}$$

it is obvious that the function space L_2 (with product topology) is linearly homeomorphic to the Banach space $L_2(T, L(U, X))$.

Let π denote the universal bilinear mapping $\pi : X \times X \to X \otimes X$; in the language of categories, the morphism π defines the tensor product as a universal repelling object [9]. The universality of the bilinear mapping π also consists in the fact that

$$\pi : X \times X \to X \otimes X, (x_1, x_2) \mapsto \pi(x_1, x_2) = x_1 \otimes x_2, ||x_1 \otimes x_2||_Z = ||x_1||_X ||x_2||_X\ ;$$

these relations are important for the analytical representation of the nonlinear functional Rayleigh-Ritz operator in terms of specification (in its construction)of the norm $||\cdot||_U$.

Next, we assume that the Cartesian square $X^2 = X \times X$ is with the norm $(||\cdot||_X^2 + ||\cdot||_X^2)^{1/2}$. In this formulation $\pi \in L\left(X^2, Z\right)$ and, in view of theorem 2 [7], for any bilinear mapping $D \in L\left(X^2, X\right)$ will always be a linear continuous operator $D \in L(Z, X)$ such that $D = D \circ \pi$, thus, for any pair $(x, u) \in N$, inclusions will be performed (as in (1^*)):

$$\pi(x, x), \pi(x, \dot{x}), \pi(\dot{x}, \dot{x}) \in L_\infty(T, Z), \pi(E(u), y), \pi(E(u), \dot{y})) \in L_2(T, Z).$$

Lemma 1. *For any set* $(A_1, A_0, B,\ D_1, D_2, D_3, D_4, D_5) \in L_2$ *and mapping.*

$$F\colon L_2(T, X) \times L_2(T, X) \times L_2(T, Y)$$
$$L_2\left(T, X^2\right) \times L_2\left(T, X^2\right) \times L_2\left(T, X^2\right) \times L_2\left(T, X^2\right) \times L_2\left(T, X^2\right) \to L_1(T, X),$$
$$(y_1, y_2, y_3, y_4, y_5, y_6, y_7, y_8) \mapsto F(y_1, y_2, y_3, y_4, y_5, y_6, y_7, y_8)$$
$$:= A_1 y_1 + A_0 y_2 + B y_3 + D_1 y_4 + D_2 y_5 + D_3 y_6 + D_4 y_7 + D_5 y_8$$

there is a single tuple of operator functions

$$(D_1, D_2, D_3, D_4, D_5, D_6, D_7, D_8) \in L_2$$

and, accordingly, the single linear mapping

$$M\colon \mathrm{L}_2(T, U) \to L_1(T, X),$$

having an analytical representation of the form

$$(z_1, z_2, z_3, z_4, z_5, z_6, z_7, z_8) \mapsto M(z_1, z_2, z_3, z_4, z_5, z_6, z_7, z_8)$$

$$:= D_1 z_1 + D_2 z_2 + D_3 z_3 + D_4 z_4 + D_5 z_5 + D_6 z_6 + D_7 z_7 + D_8 z_8,$$

such that the following functional equality holds:

$$(y_1, y_2, y_3, y_4, y_5, y_6, y_7, y_8) \mapsto F(y_1, y_2, y_3, y_4, y_5, y_6, y_7, y_8)$$

$$= M(y_1, y_2, y_3, \pi(y_4), \pi(y_5), \pi(y_6), \pi(y_7), \pi(y_8)),$$

which, in turn, induces the following operator relations for operator functions from the F *and* M *mappings*:

$$A_1 = D_1, A_0 = D_2, B = D_3, D_1 = D_4 \circ \pi, D_2 = D_5 \circ \pi,$$

$$D_3 = D_6 \circ \pi, D_4 = D_7 \circ \pi, D_5 = D_8 \circ \pi.$$

Everywhere further (in the context of the BDR problem (1)–(1*)), we assume that

$$V_N := \mathrm{Span}\{(\dot{x}, x, u, \pi(x, x), \pi(x, \dot{x}), \pi(\dot{x}, \dot{x}),$$

$$\pi(E(u), y), \pi(E(u), \dot{y})) \in L_2(T, U) : (x, u) \in N\}.$$

The following Lemma generalizes the behavioral condition (7) [10].

Lemma 2. *Let.*

$$S := \left\{t \in T : \left(g(t), w(t), v(t), q(t), s(t), h(t), \hat{u}(t), \tilde{u}(t)\right) = 0 \in U\right\},$$
$$Q := \{t \in T : \dot{g}(t) = 0 \in X\},$$

where $\left(g, w, v, q, s, h, \hat{u}, \tilde{u}\right) \in V_N$. *Then* $S \underset{\text{mod } \mu}{\subseteq} Q$ holds.

Further, let $(L_+(T, R), \leq_L)$ be the positive cone [11] of classes of μ - equivalence of all real non-negative μ -measurable on the interval T functions with the quasi-ordering $\leq_L$, where $\xi' \leq_L \xi''$ if and only if $\xi'(t) \leq \xi''(t)$ μ - almost everywhere in T. In this case, for a given subset $W \subset L_+(T, R)$, let us denote the smallest upper face of the subset W by $\sup_L W$ if this face exists in the cone $L_+(T, R)$ in the quasi-ordering structure $\leq_L$, in particular, it is easy to establish that the following relation holds:

$$\sup_L\{\xi', \xi''\} = \xi' \vee \xi'' := 2^{-1}\left(\xi' + \xi'' + \left|\xi' - \xi''\right|\right).$$

In this formulation we consider a lattice with ortho-complementation [14, p. 339] of the form:

$$R(W) := \left\{\xi \in L_+(T, R) : \xi \leq_L \sup_L W\right\}.$$

Lemma 3. *The lattice* $R(W)$ *is complete, i.e.*

$$\inf_L V, \quad \sup_L V \in R(W) \forall V \subseteq R(W).$$

Let $\Psi : V_N \to L_+(T, R)$ be the Rayleigh-Ritz entropy operator [4]:

$$t \mapsto \Psi(\varphi)(t) := \begin{cases} ||\hat{A}(t)\dot{g}(t)||_X / ||\varphi(t)||_U, \text{ if } \varphi(t) \neq 0 \in U; \\ 0 \in R, \text{ if } \varphi(t) = 0 \in U; \end{cases}$$

where $\varphi := \left(g, w, v, q, s, h, \hat{u}, \tilde{u}\right) \in V_N$. It is clear that the equality

$$||\left(g(t), w(t), v(t), q(t), s(t), h(t), \hat{u}(t), \tilde{u}(t)\right)||_U$$
$$:= (||g(t)||_X^2 + ||w(t)||_X^2 + ||v(t)||_Y^2 + ||q(t)||_Z^2 + ||s(t)||_Z^2 + ||h(t)||_Z^2$$
$$+||\hat{u}(t)||_Z^2 + ||\tilde{u}(t)||_Z^2)^{1/2} \text{holds},$$

in addition, let us call the functions

$$(g, w, v) \mapsto \eta_L(g, w, v) := ||g, w, v, 0, ..., 0||_U^2,$$
$$\left(q, s, h, \hat{u}, \tilde{u}\right) \mapsto \eta_B\left(q, s, h, \hat{u}, \tilde{u}\right) := ||0, 0, 0, q, s, h, \hat{u}, \tilde{u}||_U^2,$$

the linear and bilinear characteristics of the Rayleigh-Ritz operator, respectively.

The functional operator Ψ induces the mapping $P\Psi : P_N \to L_+(T, R)$, which, according to the tradition established in representation theory [9], we call *the projectivization* of the Rayleigh-Ritz operator:

$$P\Psi(\gamma) := \Psi\left[\gamma\right], \gamma \in P_N(\gamma \subset V_N),$$

where P_N – the real projective space associated with the linear manifold V_N (with the topology induced from the space $L_2(T, U)$); i.e. P_N is the set of orbits of the multiplicative group R^*acting on $V_N \backslash \{0\}$. In this geometrical interpretation, the key moment is the topological properties of the space P_N, $\dim P_N < \aleph_0$ and, of course, in the first place (in the context of proposition 1), its compactedness. In particular, if $\dim V_N = 3$, then a compact 2-manifold P_N is arranged as a Mobius strip, to which a circle is glued along its boundary [12]. We mention in passing that a geometric structure of a *CW*-complex can be introduced on P_N [12].

Theorem 1. *Each of the following first three conditions results in the other two*:

(i) *The BDR problem* (1)–(1*) *is solvable with respect to* $(A_1, A_0, B,\ D_1, D_2, D_3, D_4, D_5) \in L_2$;
(ii) $\exists \theta \in L_2(T, R) : \Psi(\varphi) \preceq_L \theta,\ \forall \varphi \in V_N$;
(iii) $\exists \sup_L P\Psi[P_N] : \sup_L P\Psi[P_N] \in L_2(T, R)$.
In this case, to perform $(A_1, A_0, B,\ D_1, D_2, D_3, D_4, D_5) \in L^*$, *it is necessary that.*
(iv) $R(P\Psi[P_N]) \subset L_\infty(T, R)$.

4 The Rayleigh-Ritz Operator Continuity in the Analysis of Solvability of the BDR Problem

In the case of compactness of the projective manifold P_N (i.e. $\dim P_N < \aleph_0$), it is natural to try to relate this property to the problem of constructing a lattice $R(P\Psi[P_N])$ in the context of the conditions of continuity of the projectivization of the Rayleigh-Ritz operator (see also [13]).

Suggestion 1. *Let* $\dim P_N < \aleph_0$ *and the cone* $L_+(T, R)$ *be with a topology induced by convergence in measure* μ, *or, equivalently, with an invariant metric*

$$\rho_T(f_1, f_2) := \int_T |f_1(\tau) - f_2(\tau)|(1 + |f_1(\tau) - f_2(\tau)|)^{-1}\mu(d\tau), f_1, f_2 \in L_+(T, R).$$

Then the operator $P\Psi : P_N \to L_+(T, R)$ *is continuous if the bundle N is such that*

$$\forall \varphi \in V_N \backslash \{0\} : \operatorname{supp}||\varphi_U|| = T(\operatorname{mod}\ \mu), \tag{2}$$

in particular, if

$$\forall \gamma \in P_N : \operatorname{supp} P\Psi(\gamma) = T(\operatorname{mod}\ \mu). \tag{3}$$

The following estimates will be correct:

$$\rho_T\big(P\Psi\big(\gamma'\big), \chi_\emptyset\big) = \sup\{\rho_T(P\Psi(\gamma), \chi_\emptyset) : \gamma \in P_N\}$$
$$\leq \rho_T\big(\sup_L P\Psi[P_N], \chi_\emptyset\big) < \mu(T),$$
$$\rho_T\big(P\Psi\big(\gamma''\big), \sup_L P\Psi[P_N]\big) = \inf\{\rho_T\big(P\Psi(\gamma), \sup_L P\Psi[P_N]\big) : \gamma \in P_N\}0.$$

Note that $\dim P_N = 0$ results in the proposition

$$\sup_L P\Psi[P_N] = P\Psi[P_N] = ||\hat{A}\ddot{x}||_X/(||\dot{x}||_X^2 + ||x||_X^2 + ||u||_Y^2 + ||x||_X^4$$

$$+ ||x||_X^2 ||\dot{x}||_X^2 + ||\dot{x}||_X^4 + ||E(u)||_X^2 ||y||_X^2 + ||E(u)||_X^2 ||\dot{y}||_X^2)^{1/2}. \quad (4)$$

In the context of theorem 1 and suggestion 1, we can clarify the conditions for the existence of the lattice $R(P\Psi[P_N])$. As a starting point, we introduce an auxiliary construction: for a natural number n, let $W_n$denote a finite n^{-1}-dense subset in the metric space $(P\Psi[P_N], \rho_T)$. Below, $\mathrm{Lim}_{\rho_T}\{\xi_n\}$ means the limit of the sequence $\{\xi_n\} \subset L_+(T, R)$ in the topology induced by the metric ρ_T.

Theorem 2. *Let* $\{W_i\}_{i=1,\ldots,n}$, $W_i = \{\zeta_1, \ldots, \zeta_{k_i}\} \subset P\Psi[P_N]$ *and* $f_n := \xi_1 \vee \ldots \vee \xi_n$, $\xi_i = \zeta_1 \vee \ldots \vee \zeta_{k_i}$, $1 \le i \le n$. *Then the cone* $L_+(T, R)$ *contains the lattice* $R(P\Psi[P_N])$, *if and only if.*

$$\rho_T(f_n, f_m) \to 0 (n, m \to \infty).$$

moreover, BDR solvability takes the following form: *BDR realization* (1)–(1*) *exists if and only if* $\mathrm{Lim}_{\rho_T}\{f_n\} \in L_2(T, R)$, *which is equivalent to* $R(P\Psi[P_N]) \subset L_2(T, R)$.

Example 1. Let $T = [0,\ 10]$, $Y := X$, $\hat{A}$ be the homothety operator [11] with unitary ratio, $A_1 = 0 \in L(X, X)$, $D_1 = D_3 = D_4 = D_5 = 0 \in L(X^2, X)$, $e \in X$, $||e||_X = 1$,

$$t \mapsto x(t) = (t \sin t)e, t \mapsto u(t) = 0 \in L_2(T, X).$$

Then the function $f := \sup_L P\Psi(P_N) = ||\ddot{x}||_X (||x||_X^2 + ||x||_X^2 ||\dot{x}||_X^2)^{-1/2}$ (see Fig. 1) does not belong to the space $L_2(T, R)$ and, therefore, according to theorem 1 and formula (4), the implementation of (1) for an uncontrolled process $N = \{(x, u)\}$*does not exist*.

Example 2. Let us change the setting of example 1 so that.

$$t \mapsto u(t) = \left(t \sin^2 t + 2^{-1} t^2 \sin 2t + \cos t\right)e.$$

Then (see Fig. 2) $f := \sup_L P\Psi(P_N) = ||\ddot{x}||_X (||x||_X^2 + ||x||_X^2\ ||\dot{x}||_X^2 + ||u||_Y^2)^{-1/2} \in L_2(T, R)$ and hence the implementation of (1) for a controlled process $N = \{(x, u)\}$*exists*; it is easy to establish that

$$\ddot{x} + x = 2u - 2D_2(x, \dot{x}),$$

where $D_2 = < \cdot, \cdot >_X e$, $< \cdot, \cdot >_X$ is the scalar product in X.

The following example characterizes the fact that the BDR model has a *nonstationarity* property as an endogenous factor of the differential realization of the bundle N.

Example 3. Let $T = [0,\ 1]$ and the homothety coefficient of operator $\hat{A}$ be 5, while.

$$N = \{(x, u)\}, t \mapsto x(t) = t^{1,6} e, t \mapsto u(t) = \chi_T(t)e.$$

Then (as it is easy to establish) the function $f := \sup_L P\Psi(P_N)$ according to formula (4) satisfies the inequalities.

$$0,6t^{-0,4} \le \sup_L P\Psi(P_N) \le 4,8t^{-0,4},$$

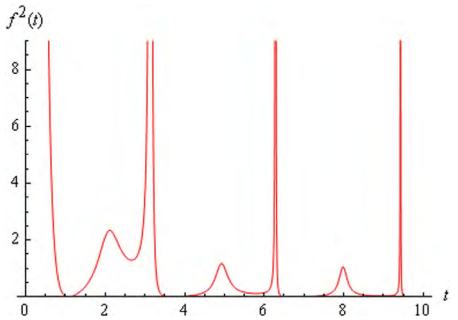


Fig. 1. $f^2(t) = (2\cos t - t\sin t)^2 \times ((t\sin t)^2 + (t\sin t)^2(\sin t + t\cos t)^2)^{-1}$

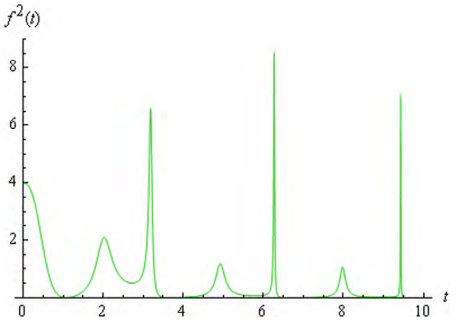


Fig. 2. $f^2(t) = (2\cos t - t\sin t)^2 \times ((t\sin t)^2 + (t\sin t)^2(\sin t + t\cos t)^2 + (t\sin^2 t + 2^{-1}t^2\sin 2t + \cos t)^2)^{-1}$

where the second inequality guarantees (by virtue of point (iii) of theorem 1) the existence of some BDR model that implements the process-bundle, while the first inequality, according to point (iv) of theorem 1, shows that this model cannot be *stationary*.

Let us give an example illustrating the case when *the linearity property* of the differential realization model is not sufficient for the precision construction of equations of bundle N dynamics, which is important when modeling the synergetic factor of neural population.

Example 4. Let $T = [1,\ 2]$, be the homothety operator with coefficient 1, while.

$$N = \{(x_1, u_1), (x_2, u_2), (x_3, u_3)\},$$
$$t \mapsto x_1(t) = \left(t^2 + 2\right)e,\ t \mapsto u_1(t) = 2^{-1}\chi_T(t)e,$$
$$t \mapsto x_2(t) = te,\ t \mapsto u_2(t) = \chi_T(t)e,$$
$$t \mapsto x_3(t) = \left(2 - 4\sqrt{2}\right)te,\ t \mapsto u_3(t) = \chi_T(t)e.$$

First, we show that the dynamic bundle N *cannot* have a linear differential realization. For this purpose, it is sufficient to establish that the linear characteristic η_L corresponding to the Rayleigh-Ritz operator, induces the function $t \mapsto \eta_L(g, w, v)(t)$ with a zero of order 2. The characteristic condition of this proposition is the following system of equations (with respect to the parameters α, β):

$$||x_1(t) + \alpha x_2(t) + \beta x_3(t)||_X^2 = ((t^2 + 2) + \alpha t + \beta(2 - 4\sqrt{2})t)^2 = 0,$$
$$||\dot{x}_1(t) + \alpha\dot{x}_2(t) + \beta\dot{x}_3(t)||_X^2 = (2t + \alpha\chi_T(t) + \beta(2 - 4\sqrt{2})\chi_T(t))^2 = 0,$$
$$||u_1(t) + \alpha u_2(t) + \beta u_3(t)||_X^2 = (2^{-1}t + \alpha t + \beta t)^2 = 0,$$

hence, it is easy to calculate that $\alpha = -1,\ \beta = 0,5$, and the zero point is $t = \sqrt{2}$.

5 Conclusion

The results proposed above confirm that a permanently developed qualitative theory of differential realization can represent a universal language for an interdisciplinary

exchange of scientific results in the framework of entropy analysis. In general, we can see that understanding the nature of multilinear models as a form of representation of equations of dynamics of complex systems (including neuromorphic ones) helps to clarify intuitive ideas about their dynamics and motivate the entire discussion.

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Human–Technology Interaction: The Cognitive Hack in the Automatic Speech Recognition Devices

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Abstract. Many significant changes and shifts in daily human life have occurred in the digital era because of technology, with claims that the newest technology makes life more comfortable and more efficient, increasing quality of life. In particular, the introduction of artificial intelligence (AI) devices that depend on automatic speech recognition (ASR), such as Siri from Apple, Alexa from Amazon, Google Assistant from Google, and others, have led to a digital voice community that is formed by the interaction with those AI devices. Using a critical cognitive approach to the ethics and privacy of that community, this paper integrates various interdisciplinary fields to provide a foundational analysis for a model of cognitive hack in the AI digital voice community. In addition, the paper discusses the strategies of manipulation and deception of a targeted audience.

Keywords: Automatic speech recognition (ASR) · Artificial intelligence (AI) · Cognitive hack · Manipulation · Deception · Targeted audience · Hidden command · Hidden affordance · Psychoacoustic hiding · Voice community

1 Introduction

Automatic speech recognition (ASR) devices are broadly utilized in modern societies all over the world. ASR innovation has begun to alter the way people live and work and has become essential for people to connect with some devices (Yu and Deng 2015). As of 2017, almost 50% of adults in the United States were estimated to be using voice assistants as part of their daily routine. The SlashGear website reported that 100 million Alexa-enabled devices had been sold, including both Amazon products and Alexa-built-in third-party devices (Stattelman 2020). Over the past few decades, the technology involved in speech recognition, speech synthesis from the identification of speaker identity, and digital storage and manipulation of speech, has seen enormous advances. The user must be aware of not only the implications of certain technologies and the literature pertaining to how to use these technologies efficiently, but also of some of the underlying technologies. Thus, it is necessary to briefly introduce the concept of a voice-based community, to distinguish the technical infrastructure of the cognitive hack within ASR networks. Victor W. Zue (1985) states, "In automatic speech recognition, the acoustic signal is the only tangible connection between the talker and the machine.

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 200–206, 2022.
https://doi.org/10.1007/978-3-030-85540-6_26

While the signal conveys linguistic information, this information is often encoded in such a complex manner that the signal exhibits a great deal of variability" (p. 1). Lawrence R. Rabiner describes this community as "eyes-free" and "hands-free" communication (p. 9912). These machines aim to mimic human behavior and to be capable of talking normally and reacting appropriately to human language. ASR innovations empower machines to react effectively and reliably to the human voice and offer helpful and important forms of assistance.

ASR devices can communicate with terminals to collect data, such as speech utterances, from the terminals (Rose et al. 2008). Gianni D'Angelo and Salvatore Rampone (2018) argue this:

> *places human beings in front of a new model of life, one that is based on a new concept of the cognitive process. In such a view, the way people interact with information and technological systems, in general, is being affected by radical changes. Human cognition, through its mental actions such as memory, senses, reasoning, and attention is no longer the main engine that allows individuals to represent the external world, but it is integrated into the world itself as a component, and it acts through a complex human-computer interaction. (p. 1)*

This has prompted humanities researchers to challenge the new model of advanced voice networks, which introduces new threats and challenges related to the user's privacy and security.

2 Psychoacoustic Hiding and Hidden Command

Psychoacoustics is the concept of how sound is interpreted and recognized by humans. It involves the study of the systems that interpret sound waves in the human body as well as the processes that take place in the brain when we listen (Hahn 2020). The human auditory system can only process sound waves within a certain range of frequencies: between 20 Hz and 20 kHz. For the most alert human listeners, 20 kHz is the upper limit (Hahn 2020). Frequencies below 20 Hz become more like a collection of tones and cease to sound like a continuous tone; frequencies above 20 kHz completely disappear. Thus, most psychoacoustic hiding attacks are focused on the use of algorithms of gradient descent; importantly, as they modify the audio signal instead of updating the neural network, they harness the power of listening thresholds to ensure that everything in a normal audio file works as it should. This means that it is easy to hide a transcription in any audio file. Such attacks are feasible and can have malicious intent. This makes them a significant challenge, as they are difficult to predict and to identify whether malicious messages and attacks have been hidden by an audio piece under a simple type of file (Stattelman 2020). In the field of computing, this kind of attack is demonstrated using a new form of psychoacoustic hiding-based adversarial examples. The attributes of deep neural network (DNN) based ASR systems are exploited by this type of attack (Schönherr et al. 2018) where the perception of sound manipulates cognition in the human brain to perform a particular task. Lea Schönherr et al. (2018) applied a psychoacoustic model and manipulated the acoustic sign Al below the thresholds of human perception. To further minimize the perception of risk, attackers use forced alignment to achieve the

best-fitting temporal alignment between the original audio sample and the malicious target transcription. For instance, the attack would compromise the personal details of the victim, including their contact lists, emails, credit card information, and so on.

3 Human–Computer Interface Design and the Hidden Affordance in ASR Devices

One of the most common ways to interact with devices is through a voice user interface (VUI). This allows the user, via voice or speech commands, to communicate with a device. VUIs are generally accepted as input methods for a diverse range of devices, with their increase in use driven by rapid developments in ASR, which in many projects now are consistent with human listening. These improvements are based on the continuous evolution of the deep neural networks (DNNs), which are the core of ASR computation. Recent research results show, however, that DNNs are vulnerable to the adversarial disruption that enables attackers to force a malicious output into the transcription. Mehrabani et al. (2015) explain about VUI, speech recognition or speech to text systems use acoustic and language models decoding the speech signal into the likeliest sequence of words. Acoustic models represent the statistical relationship between acoustic observations and the linguistic units (e.g., phonemes), while the role of language models is to capture the regularities of the natural language. Statistical language models (SLM), which are widely used in large vocabulary continuous speech recognition (LVCSR), tend to consist of probability distributions of linguistic units (e.g., words). Another group of language modes are context-free grammars (CFG), which rely on linguistic rules. While building an SLM requires a considerable amount of training data, rule-based language models can be created for a specific application based on what the end-users are expected to say (e.g., dialog systems). CFGs can also provide the text and semantic tags associated with the text in one step. However, grammar-based language models are more restrictive than SLMs. Furthermore, Robert Jerrard explains that, "the human element is both central and superior in the interrelation […] The consideration of human factors in all machine use may be described as a recognition of the importance of human beings as elements in a system. Such systems should be efficient, reliable, and, above all, purposeful" (p. 21).

As technology has developed, it has become possible to hide data and information in various ways, such as using steganography and coded images, and hidden commands and audio files. According to affordance theory and its confirmation of the interaction between an individual and their environment, to obtain the benefits of embedded secure communication, a user should take advantage of a machine's flaws. This is why this type of study has origins in the humanities. Affordance theory is defined by William W. Gaver (1991) when a user is not aware of an accessible system's inner structures and operation. It also "may be present for only one individual or a group of individuals but not for others" (Nagy and Neff 2015, p. 3). When affordances are perceivable, they provide a clear relation between awareness and behavior; concealed and false affordances lead to mistakes (Gaver 1991). Artificial Intelligence advancement and its direct interaction with human life, alongside the use of other platforms, give it the benefit of large scope and human control. This provides a user, whether a developer and a recipient of coded

messages, a chance to breach the notion of deep neural learning. It is not a matter of transmitting secure correspondence and concealing it in an unaware manner. Rather, it is a matter of using big data and information transmission for specific purposes and objectives other than the well-meaning motivations for developing that technology.

4 The Cognitive Hack

Marvin Zelkowitz provides a definition of the cognitive hack, stating that it "refers to a computer or information system attack that relies on changing human users' perceptions and corresponding behaviors to be successful", which is "in contrast to the denial of service (DOS) and other kinds of well-known attacks that operate solely within the computer and network infrastructure" (2004, p. 35). This definition clearly describes a difference between a cognitive attack and a technical attack on ASR devices. Saransh Mittal (2019) also defined cognitive hacks, stating that they "are designed to affect people's behaviors in a way that serves the attacker's purpose. The cognitive hack is a cyberattack that seeks to manipulate the perception of people by exploiting their psychological vulnerabilities" (p. 1). As such, in the ASR voice community, the cognitive hack has three key features. First, it occurs within an information and data transmission environment, due to the fact that a context is entirely constructed in the sense of ASR. Second, it involves an ASR voice community defect. Third, it places cognitive and physical constraints on the user.

5 Information Operations in the Digital Voice Community

Deceptive Content. To illustrate the nature of information and data within the ASR voice community, the concept of information operation must be linked to the human–ASR interaction. Traditionally, the concept 'information operations' relates to various aspects of military strategy, including strategic operations and propaganda, used to support information warfare (Waltzman 2017). One tactic of information operations is to manipulate and deceive the target audience into utilizing legitimate and suspicious platforms, a task which must be skillfully and deliberately achieved, for instance by using propaganda in marketing to ASR devices. This propaganda gains power over the individual, blinding them to reality; it paralyzes the individual's reaction to the potential threats when using the ASR device. S. Jowett defines propaganda as, "suspicious rhetoric" (1986, p. 3); it is similarly described by Anthony R. Partkanis and Elliot Aronson, as "deliberately deceptive communication" (2007, p. 8). The effectiveness and deception of propaganda arise from its use of persuasive strategies; the persuasive and rhetorical aspects of propaganda are fundamental in creating a fertile and secure setting for online attackers or hackers to hide their true intent and purpose. Scientists have conducted studies and developed various approaches to analyzing propaganda; thus, there are different perspectives and analytical frameworks available with which to classify propaganda, such as economic, political, psychological, sociological, and historical scientific frames. What is most important to note about propaganda is its rhetorical and persuasive functions that enable it to penetrate daily communications. DeVito (1986) defines propaganda as, an "organized persuasion", which combines persuasive technology with ideological concepts to shape public opinion and influence decisions. Leonard

Doob (1986) similarly defines propaganda as, "the attempt to affect the personalities and to control the behavior of individuals towards desired ends" (p. 4). Ellul (1973) also considers propaganda a sociological phenomenon, stating that "propaganda is no longer a self-contained action, covering up for evil deeds. It is an object of serious thought and proceeds along scientific channels" (p. 5). The process of affecting an individual's values, beliefs, attitudes, ideas, and thoughts leads the audience to a specific pattern of thinking. It provides people with a pseudo-freedom in their use of ASR devices in daily life.

6 Human Dimensions of Cyber Cognitive Hacks in ASR Devices

The Consent of the User. A cyber cognitive hack can be caused by a human factor. It is universally understood that people are the most vulnerable connection in cyber security, to the degree that it is said, "users are the enemy" (Mehrabani et al. 2015). Researchers have conducted many studies to comprehend the behavior of the client while managing network security issues. Attempts have been made to identify client conduct through different studies in criminology to comprehend "the motive and opportunities" available to the user as they interact with the computer system (Mittal 2016). The aspects of visualization and social space are absent from ASR devices and there is no visual affordability that seems to be used and dealt with by a customer. ASR devices, therefore, come with detailed instructions and guidelines on how to communicate with the devices properly.

The psychological dimension of the client is helpful to understand the issue of cyber cognitive hacking in more depth. Risk, uncertainty, and vulnerability are difficult concepts for people to assess. For developers of security frameworks, it is imperative to see how clients assess and settle on choices regarding security In other words, human behavior is guided by their perception of the potential risk in ASR devices. Ryan West (2008) argues that, "People do not perceive gains and loss equally. This suggests that while in a system the designer may consider the cost of security effort small, the loss could be perceived as worse than the greater gain in safety. Put simply, the user must perceive a greater magnitude of gain than loss" (p. 38). In addition, there is the absence of social guidance on working with ASR devices on a regular basis, where the consumer is likely to be using them alone, at home, most of the time. Jacques Ellul (1973) presents a sociological phenomenon that is the 'lonely crowd', observing that, "The most favorable moment to seize a man and influence him is when he is alone in the mass" (p. 9). Rand Waltzman (2017) further observes that, "Interaction within the information environment is rapidly evolving, and old models are becoming irrelevant faster than we can develop new ones" (p. 2). The result is uncertainty, which leaves people exposed to dangerous influences without adequate defenses. This makes persuasive strategies more likely to be successful, because the individual's psychic defenses are weakened, their reactions are easier to provoke, and the attackers benefit from both the process of the pressures felt by an individual when in a group. Emotionalism, impulsiveness, and excess are all characteristics of the individual caught up in a mass.

7 Cognitive Security in the ASR Digital Voice Community

Cognitive protection (COGSEC) is a new area that focuses on the changing frontier of cognitive security, and academics, governments, social media, and private actors are participating in an ongoing arms race to control and protect large numbers of online users, now and in the future, from influence (Waltzman 2017). In this context, cognitive security experiments and studies should seek to protect the privacy and security of users in the ASR digital voice community.

8 Conclusion

The integration of ASR devices in modern life makes it necessary for researchers to pursue interdisciplinary studies on how to tackle cognitive hacking of ASR devices. In order to include all of its dimensions, the issue must also be addressed as an interdisciplinary matter. For instance, research in cognitive science, computer science, engineering, social science, security, marketing, and psychology should be included. The human–interaction approach has been found to be effective in analyzing this contemporary issue.

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Participatory Visual Process Analysis of Manual Assembly Processes to Identify User Requirements for Digital Assistance Systems

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Abstract. This paper contributes to the field of Human-Centered Design by introducing a new method for participatory visual analysis of manual assembly processes in factories to identify user requirements for digital assistance systems. The process-oriented, visual method integrates the process, need for information, automation level as well as the worker experiences within the process. With the help of the method, user requirements can be derived, and assistance potential can be identified.

Keywords: Digital assistance system · Industry 4.0 · User-centered design

1 Introduction

Digital assistance systems will play an important role in the future by supporting employees and cooperating with them in order to increase productivity, ergonomics and flexibility. Digital assistance systems must be designed in such a way that they optimally support the abilities of the employees in an adaptive manner. Developed assistance systems can offer vast advantages both on technical as well as economical criteria but are not accepted or used by system users due to poor implementation [1]. User centricity and user participation in the design process is therefore an essential, but up to now neglected part in the development of manufacturing assistance systems [2].

This paper presents an approach to systematically analyze assembly processes with the focus on participation and how to identify user-needs to design productive and accepted digital assistance systems for smart factories of the future.

2 Related Work

This chapter provides an overview of the related work together with basic terminology relevant for this paper.

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 207–214, 2022.
https://doi.org/10.1007/978-3-030-85540-6_27

2.1 Manual Assembly Process

Manual assembly refers to assembly tasks that are carried out by humans. This involves the use of their hands, dexterity, and intelligence. In addition, aids such as tools, devices and gauges are used. As the human forms the center of the assembly process, its performance is a very important factor for designing manual assembly systems [3].

Increasingly variable products, complex and changing assembly contents and disadvantages of static information systems lead to high learning times, rising failure rates and loss of productivity [4].

2.2 Digital Assistance System

Assistance systems are generally understood to be technical systems that record and process information from the work environment or through manual input in order to support people in a work task. Depending on the type of system support, a distinction is made between energetic-physical and informational support [5–8].

On the other hand, digital assistance systems help to provide the employee with supportive information in order to avoid assembly errors, to shorten learning processes, to increase work productivity and to enable more flexible, efficient and individually designed processes. Consequently, informational assistance systems are technical systems that record and process environmental and input information and make the processed content available to the employee for cognitive support and relief [5, 8–10].

The assistance systems, which are made up of hardware and software, have input and output systems as well as specific software for system control. This is used to record input information, which may be supplemented by real-time and product data, transformed for information output and finally output. Furthermore, communication with connected assembly peripherals must be considered for the specification definition of digital assistance systems.

This means that digital assistance systems by definition go beyond purely cognitive and informational support and can also communicate with connected auxiliary and operating resources and tools [4, 11, 12].

2.3 Participatory Design in Manufacturing

Participatory design first became popular in Scandinavia in the early 1970s with the Norwegian Industrial Democracy programme [13, 14]. Initial participatory design focused on working with unions around technology implementations and workplace policies [13, 15].

What we now consider participatory design began to take shape in the 1980s, beginning with the Swedish-Danish UTOPIA project [14]. At that time, technology was seen as attributed to a dehumanisation of work, leading to a division of the workplace, increasingly creating rigid and routine tasks and shifting power to management and the top of companies [13]. In this environment, designers sought to empower workers by creating technologies that were aligned with workers' interests [13, 16]. Therefore, the UTOPIA project sought to bring graphic workers and their unions together with computer scientists, social scientists, industrial designers and graphic designers in the development of

"tools for skilled work" [14, 17], so that unions could develop a preferred technology for the workplace [13]. Although the UTOPIA project was not successful, but it did show a way for workers to be involved in technology development. Methods such as "design-by-doing" and "design-by-playing" [14].

Participatory design is embedded in the socio-technical systems of the world so that it can be used as a tool to give employees a voice and thus more successful implementation in organisations.

3 Research Gap and Problem Statement

Not only the properties of the technical components and implemented functions, but above all the fulfilment of user needs determine the performance characteristics of an digital assistance system and the subsequent user acceptance [18]. The requirements of the employees with regard to use are made up of generally valid needs and individual wishes. The general user requirements in terms of usability are laid down in the DIN EN ISO 9241-110 and in terms of user experience in DIN EN ISO 9241-210. It is more difficult to define the subjective, non-task-related criteria of a target group. The question arises as to how positive user experience arises, or what individual expectations users have of a system.

Furthermore, participation, i.e., the direct involvement of users in the development process, plays a decisive role with regard to acceptance [19].

The analysis of the relevant literature shows that no methodologies, methods, models, procedures and approaches exist to systematically analyse, visualize and determine the need for digital assistance in existing manual assembly processes based on the respective user requirements in a participative way (see Table 1).

Table 1. Evaluation of existing approaches and methods for developing Digital Assistance Systems

Requirement / Author	Identifying requirements based on work tasks	Considering individual human characteristics	Considering human subjective experience	Considering worker acceptance	Participative task analyzing approach
Geiser [5]	●				
Hinrichsen [4]	●	●	◐		
Hold [20]	●	●	◐	◐	
Lušić [21]	●	◐			
Merkel [22]	●	●	●		
Reinhart [23]	●	◐			

Classical human-machine planning methodologies tend to consider later design phases and include visual design, output and screen displays as well as the design of

meaningful dialogue guidance. None of the methodologies describes how user integration and the detailed elicitation and processing of user requirements can be realised in the context of manual assembly.

Therefore, the following goal was defined: Development of a concept for the visual analysis, identification of potentials of digital assistance systems in manual assembly processes based on user requirements and the intended potential benefits.

4 Research Method

In a first step, the essential methods from the areas of user experience, human-machine interaction and work task analysis must be summarised based on the research question and the state of the art. In parallel, exploratory interviews were conducted with production employees to determine the main user needs and participation requirements. The interviews were based on findings from the areas of technology acceptance and user experience.

These results are the basic requirements for adapting a suitable method that is able to analyse both the assembly process and the industrial user experience with the aim of deriving assistance potential for digital assistance systems. Finally, the method was tested and optimised in an industrial trial (see Fig. 1).

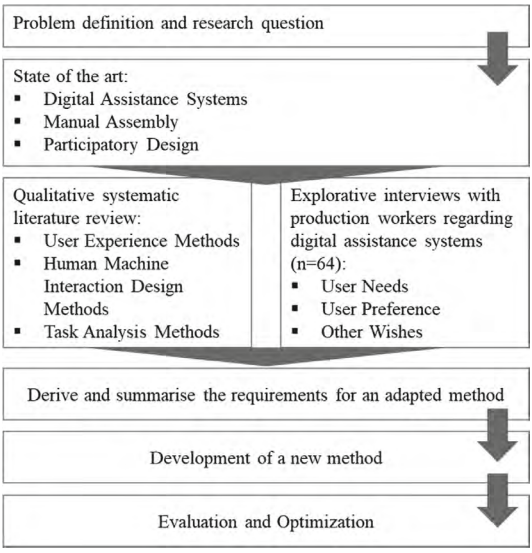


Fig. 1. Research design

5 Results and Validation

The suggested methodology is based on Customer Journey Mapping which must adopted and adjusted to this new application domain. Customer Journey Mapping is a process-oriented, visual method from the user experience field for structuring and conceptualizing

human experiences and helps companies understand how customers use and perceive the different channels and touchpoints with the company and how they fundamentally envision that experience [24]. The adopted Customer Journey Map is named Assembly Journey Map.

This approach is appropriate for the analysis task formulated. The interaction between employees and the assembly process must be understood and the user requirements for an optimal process must be derived. The overall procedure is shown in Fig. 2 and was applied at an automotive manufacturer.

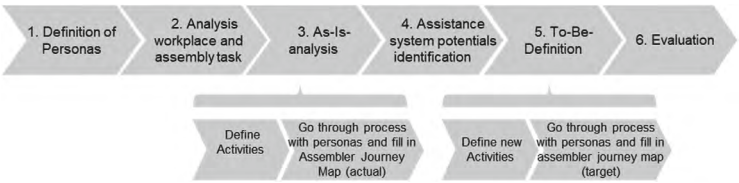


Fig. 2. Assembly journey procedure

The training process for a long-cycle assembly job with a large assembly scope is considered. The target group that is to be trained for the assembly workplace consists of employees from different areas of production who have different levels of prior knowledge with regard to the activity to be carried out, but who do not yet have any work experience at the assembly station under consideration. Furthermore, all employees have

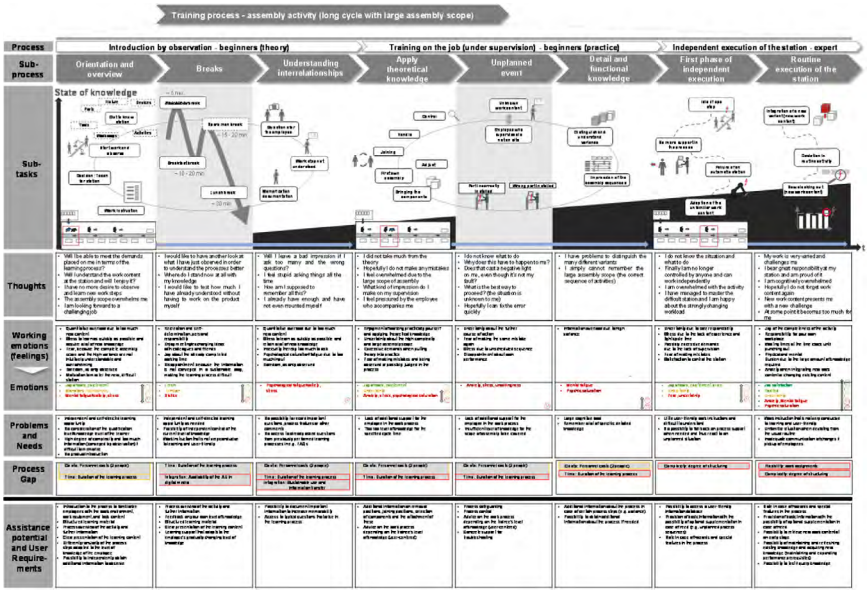


Fig. 3. Exemplary assembly journey map for training process

a task-related, technical education and do not have any physical impairments that need to be taken into account.

With reference to the illustrations in Fig. 3, it becomes clear that there is considerable assistance potential with regard to the individual sub-processes of the learning process.

It is also clear from the described problems from the employee's point of view that the learning process hardly takes into account the respective level of knowledge and the types of knowledge and learning objectives to be imparted in this regard. From the observations of the Assembly Journey Map - especially the sub-process "Apply theoretical knowledge" - it can be concluded that due to the large number of assembly processes with many variants that have to be carried out one after the other, the complexity with regard to decision-making for the control and execution of his actions will sooner or later overwhelm the employee. In order to be able to implement a suitable optimisation measure in this regard through the use of a worker assistance system, it is necessary to clarify, among other things, how the system could and should best support the worker in his cognitive processes of information processing and human action regulation.

6 Discussion

As Fig. 3 shows, the process model described, and the elements developed in it are also suitable for identifying specific digital assistance potentials at the level of key activities in addition to analysing a work system or the everyday work of an employee in assembly. With regard to the representation of the customer journey maps, changes have been made, such as the visualisation of different information flow partners in the process or process times and the introduction of sub-process steps, which can be helpful for understanding the process.

7 Conclusion and Further Work

To develop a process model for the user-centred design of digital assistance systems in assembly, the customer journey method from the user experience area was taken up and adapted for the visual and participatory analysis of assembly work activities. In order to be able to examine and evaluate work activities in terms of the actual user experience and its impact on the employee and his or her activity, the analysis has been carried out at the level of the work system and the key activities based on the customer journey.

As a result of the analytical investigations, it can be stated that the Assembly Journey Map can be used very well for the analysis of assistance needs in the everyday work of an employee in assembly as well as for the analysis of specific work situations with a higher level of detail. In this context, the actual Assembly Journey Maps provide a comparison of the experience from the user perspective with the performance assessment of processes from the company perspective.

In particular, the high degree of user-centricity underlying the methodology makes it possible to obtain a comprehensive idea of the emotional and psychosocial influences of the work system on people in the respective situation and to trace their impact on human actions via the respective state of mind.

In order to confirm the statements made on the effect of the measures of the design recommendations for employees and process in practice, these are to be tested in the context of implementation in a pilot application under the assumed conditions. In this context, the evaluation and success measurement of the effect of the measures for employees and process in the context of an actual and target state in the form of key figures could be of great importance. For this purpose, suitable production related KPIs and, above all, KPIs that make it possible to measure the user experience of the employee in the respective work situation must be identified and validated. A profitability analysis of the worker assistance systems with regard to acquisition and usage costs, which is not considered in this work, should also be included for piloting.

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Volume Control Methods to Reduce Audible Discomfort for Watching Videos

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Abstract. Currently, the burden on the ears is increasing with the increase in the viewing rate of videos due to the new coronavirus. Therefore, the purpose of this study is to reduce the discomfort of video advertisements. For this purpose, we proposed a method to reduce the discomfort by smoothing the volume change, and conducted evaluation experiments on its effectiveness. In the evaluation experiment, 65 kinds of created sounds were presented to 10 subjects, and they were asked to answer their impressions of "discomfort" of the three parts of the presented sounds (music, junction, and advertisement) on a rating scale. As a result of the evaluation experiment, it was found that the use of the proposed type of cheek in the junction part reduced the overall unpleasantness compared to the case where it was not used.

Keywords: Video viewing · Music · Video advertisements · Volume change · Discomfort · Fade-in

1 Introduction

Since the time spent at home is increasing due to the spread of the new coronavirus, it is estimated that the viewing rate and frequency of use of "video distribution services" will increase [1]. Furthermore, a rapidly expanding market is video advertising [2]. The current situation is that video advertisements are cheaper to produce than TV commercials, and there are many complaints about the high volume at the beginning of the video because of the lack of regulations in place [3, 4]. Head phone hearing loss (earphone hearing loss) is characterized by a gradual progression and gradual loss of hearing in both ears, making it difficult to recognize hearing loss in the early stages [5]. The WHO also states that there is a risk of hearing loss if one continues to listen at 80 dB for more than 40 h per week or at 98 dB for more than 75 min per week [6, 7]. In addition, loud noises above 100 dB can cause sudden hearing loss. In particular, headphones and earphones allow sound to enter directly into the ears, so listening so loudly that the sound leaks into the surroundings or listening for long periods of time can cause hearing loss. WHO recommends the following to protect the health of your ears when listening to music or other music with headphones or earphones. Turn down the volume or take a break from continuous listening. Limit use to less than one hour per day. Reduce ambient noise.

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 215–223, 2022.
https://doi.org/10.1007/978-3-030-85540-6_28

Choose noise-canceling headphones or earphones [8]. The ultimate goal of this study is to reduce discomfort in video viewing. Previous research includes the study of optimal volume attenuation methods that are unnoticeable to the listener. Experiments on adults and the elderly have been found to yield similar results [9]. It has also been found that attenuation at a fast rate is difficult to achieve [5].

Based on the above research, this study proposes a method to reduce discomfort by smoothing out the volume change using fade-in as a preliminary step for the purpose, and conducts evaluation experiments on the effectiveness of the method.

2 Proposed Method

The proposed method uses the volume of the PC (20, 40, 60, 80, 100) to linearly fade in from low volume (m) to high volume (m) until t[s] at the beginning of the advertisement. Here, we set t = 5[s] for proposed method 1 and t = 10[s] for proposed method 2. In addition, the high volume (M) is maintained from t[s] to T[s].

"Wave Pad audio editing software" was used to edit the advertisement to follow the proposed method. The editing process is summarized in Fig. 1. The volume combinations from low volume (m) to high volume (m) are shown in Table 1.

Table 1. Volume combinations from low volume (m) to high volume (M)

m	m → M
20	20 → 40, 20 → 60, 20 → 80, 20 → 100
40	40 → 60, 40 → 80, 40 → 100
60	60 → 80, 60 → 100
80	80 → 100

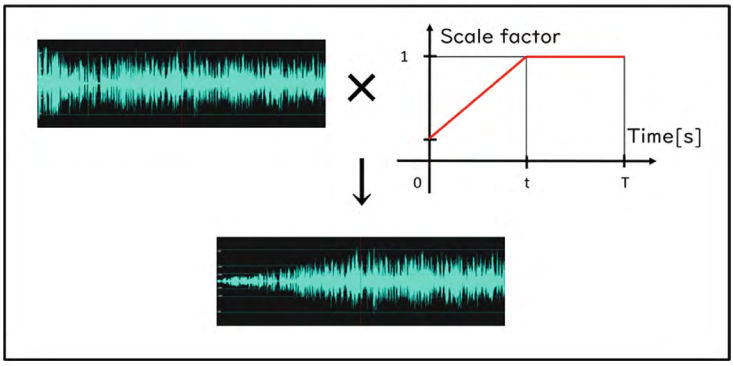


Fig. 1. Proposed method

3 Experiment

3.1 Experimental Methods

The experiment was conducted from January 25, 2021 to January 29, 2021 on 10 adult males aged 21 to 23 years in a soundproof room at the Tobata Campus of Kyushu Institute of Technology. To simulate video viewing in a real environment, the subjects were seated on a chair, headphones (SENNHEISER HD650) were worn, and a long desk, PC (UNITCOM CTO PC biz-M), keyboard (Microsoft Wired Keyboard 600), and mouse (E-C A long desk, a PC (UNITCOM CTO PC biz-M), a keyboard (Microsoft Wired Keyboard 600), a mouse (E-C 011-03-5046(B)), and a monitor (PHILIPS 224E5EDSB/11) were set up in front of the PC, and the presentation sound was played by the PC and headphones.

For the evaluation, the subjects were made to sit in a chair in a soundproof room, headphones were put on, and they were given a questionnaire and a ballpoint pen. Then, using the questionnaire, they were asked to answer their impressions on the rating scale for the three parts of the presented sound (music, junction, and advertisement). For this purpose, a table was created in which they had to fill in their evaluation of "discomfort" by choosing from a scale of 1 to 5: <1, not uncomfortable>, <2, rather uncomfortable>, <3, rather uncomfortable>, <4, uncomfortable>, and <5, very uncomfortable>. In order to avoid gradual changes in the volume of the presented sounds, numbers from 1 to 65 were assigned using random numbers, and the subjects were asked to listen to the sounds in that order.

3.2 Specification of Recording Sounds

dB measurements of music and advertisement were conducted in a soundproof room using a long desk, headphones, PC, keyboard, mouse, monitor, sound level meter (RION SOUND LEVEL METER NL-42), and dummy head. Table 2 shows the dB measurements in the soundproof room when there was nothing in the room.

The song used the last 25 s of "Kousui" (song title) by "Eito" (Japanese singer's name), which was released on April 21, 2019 on various music distribution services. As of September 13, 2020, the song has been played more than 100 million times on YouTube, and was selected as one of the best new words and phrases in Japan on November 5, 2020. Table 3 shows the dB measurements of the volume of each of the recordings made with the Aiseesoft screen recorder in a soundproof room.

The advertisement uses the first 15 s of the "Rakuten UN-LIMIT V Easy Application" 30-s video, which has been available on the "Rakuten Mobile [Official]" YouTube channel since November 4, 2020. The first 15 s were used. This advertisement has received many complaints on the Internet that it is too noisy, and the specifications of the commercial have been changed many times. Table 4 shows the dB measurement of each volume recorded by Aiseesoft screen recorder in a soundproof room.

Table 2. dB measurements of soundproof rooms

Time [s]	Average [dB]	Maximum [dB]	Minimum [dB]
10	18.9	20.6	17.6

Table 3. dB measurements of music

Volume	Left ear [dB]			Right ear [dB]		
	Ave.	Max.	Min.	Ave.	Max.	Min.
20	39.1	50.3	33.1	39.5	51.1	32.1
40	49.9	59.2	37.7	49.9	58.2	37.8
60	56.8	65.2	42.1	56.8	65.2	43.3
80	61.8	70.2	46.4	61.8	70.3	45.4
100	65.5	74.1	49.2	65.6	74.1	51.4

Table 4. dB measurements of advertisements

Volume	Left ear [dB]			Right ear [dB]		
	Ave.	Max.	Min.	Ave.	Max.	Min.
20	39.4	54.1	35.7	39.3	55.3	35.6
40	49.9	56.9	43.9	49.9	56.9	44.1
60	56.9	63.9	50.6	56.8	63.9	50.6
80	61.8	68.9	55.6	61.9	68.9	55.5
100	65.6	72.6	59.3	65.6	72.6	59.3

3.3 Making of Presentation Sounds

"Wave Pad audio editing software" was used to create presentation sounds of 40 s in total, in the order of music and advertisement. The presentation sound consists of the following three types (a), (b), and (c), and the number of sound sources is 25, 20, and 20, respectively, for a total of 65.

Presentation sound (a): Presentation sound without the proposed method.
Presentation sound (b): Presentation sound using the proposed method 1 ($t = 5$[s]).
Presentation sound (c): Presentation sound using the proposed method 2 ($t = 10$[s]).

4 Experimental Results

4.1 Hearing Level of Subject

The subjects were ten adult males between the ages of 21 and 23. The average hearing level was calculated from the hearing of the subjects measured using an audiometer, and it was confirmed that all subjects had normal hearing. The average hearing level was calculated using the quadrature method B shown in Eq. (1). The variables in Eq. (1) represent the following hearing levels, respectively [10].

HL_{500}: Hearing level at 500 Hz, HL_{1k}: Hearing level at 1 kHz,
HL_{2k}: Hearing level at 2 kHz, HL_{4k}: Hearing level at 4 kHz.

$$(HL_{500}[dB] + HL_{1k}[dB] + HL_{2k}[dB] + HL_{4k}[dB]) \div 4 \tag{1}$$

4.2 Evaluation Results of the Music Part

Tables 5, 6, and 7 show the mean scores for "discomfort" of the musical parts of the presented sounds (a), (b), and (c), respectively.

Tables 6, 7, 9, 10, 12, and 13 explain the volume change of the advertisement. When the volume of the music is 20 and the volume of the advertisement is 80, the low volume (m) is 20 and the high volume (m) is 80. When the volume of the music is 80 and the volume of the advertisement is 20, the low volume (m) is 20 and the high volume (M) is 80.

A discussion of the results of the music portion of the experiment is presented. From Tables 5, 6, and 7, it was found that the mean score for discomfort increased as the volume of the music increased for all the presented sounds (a), (b), and (c). This may be due to the fact that there was no sound immediately before the music and it was not affected by other sounds.

Table 5. Mean score for "discomfort" of the music part (a)

	Ads: 20	Ads: 40	Ads: 60	Ads: 80	Ads:100
Music: 20	1.2	1.2	1.3	1.1	1
Music: 40	1.6	1.8	1.2	1.5	1.7
Music: 60	2.6	3	2.3	2.6	2.2
Music: 80	3.4	3.4	3.9	3	3
Music: 100	4.8	4.6	4.9	4.5	4.6

Table 6. Mean score for "discomfort" of the music part (b)

	Ads: 20	Ads: 40	Ads: 60	Ads: 80	Ads:100
Music: 20	–	1.2	1.3	1.3	1.3
Music: 40	1.5	–	1.5	1.4	1.5
Music: 60	2.6	2.6	–	3.3	2.6
Music: 80	4	3.6	3.5	–	3.3
Music: 100	4.8	4.1	3.9	4.7	–

Table 7. Mean score for "discomfort" of the music part (c)

	Ads: 20	Ads: 40	Ads: 60	Ads: 80	Ads:100
Music: 20	–	1.2	1.3	1.3	1.2
Music: 40	1.9	–	1.3	1.8	1.5
Music: 60	2	2.8	–	2.1	2.5
Music: 80	3.6	3.4	3.5	–	3.9
Music: 100	4.9	4.5	4.8	4.5	–

4.3 Evaluation Results of the Junction Part

Tables 8, 9, and 10 show the mean scores for "discomfort" of the junction parts of the presented sounds (a), (b), and (c), respectively. A discussion of the experimental results for the junction part is presented. Tables 8, 9, and 10 show that the mean scores of the presented sounds (b) and (c) are generally lower than those of the presented sound (a), indicating that both of the proposed methods 1 and 2 can reduce discomfort. The reason why there was no significant difference in the mean scores of discomfort between the presented sounds (b) and (c), although there was a difference in the time of fade-in between the proposed methods 1 and 2, may be that there was no clear definition of the evaluation of the junction and there was no index for subjects to judge the junction.

Table 8. Mean score for "discomfort" of the junction part (a)

	Ads: 20	Ads: 40	Ads: 60	Ads: 80	Ads:100
Music: 20	1.3	3	3.8	4.6	4.7
Music: 40	1.5	2.1	3	3.8	4.8
Music: 60	2.1	2.1	2.7	3.8	4.2
Music: 80	2	2	2.5	2.2	3.7
Music: 100	2.1	1.8	2.3	3.1	4

Table 9. Mean score for "discomfort" of the junction part (b)

	Ads: 20	Ads: 40	Ads: 60	Ads: 80	Ads:100
Music: 20	–	1.7	1.9	2.5	2.4
Music: 40	1.6	–	1.9	1.8	3.4
Music: 60	1.6	1.8	–	2.8	2.9
Music: 80	1.9	2.4	2.3	–	2.7
Music: 100	2.3	2.6	2.5	3.6	–

Table 10. Mean score for "discomfort" of the junction part (c)

	Ads: 20	Ads: 40	Ads: 60	Ads: 80	Ads:100
Music: 20	–	1.6	1.4	1.5	1.5
Music: 40	1.5	–	1.9	2.3	1.8
Music: 60	1.5	1.6	–	2.2	3.4
Music: 80	1.6	1.6	2.6	–	3.7
Music: 100	2	2.3	2.9	2.8	–

4.4 Evaluation Results of the Advertisement Part

Tables 11, 12, and 13 show the mean scores for "discomfort" of the advertisement parts of the presented sounds (a), (b), and (c), respectively. A discussion of the experimental results for the advertisement part is presented. From Tables 10, 11, and 12, it was found that for all of the presented sounds (a), (b), and (c), the average score for discomfort increased as the volume difference between low volume (m) and high volume (m) increased.

Table 11. Mean score for "discomfort" of the advertisement part (a)

	Ads: 20	Ads: 40	Ads: 60	Ads: 80	Ads:100
Music: 20	1.3	2.1	2.8	4.1	4.6
Music: 40	2.1	2.1	2.5	3.5	4.6
Music: 60	1.9	1.7	2.2	3.8	3.6
Music: 80	1.8	1.6	2.4	2.7	4.1
Music: 100	1.9	1.6	2.2	2.9	4.2

Table 12. Mean score for "discomfort" of the advertisement part (b)

	Ads: 20	Ads: 40	Ads: 60	Ads: 80	Ads:100
Music: 20	–	1.7	3.1	4.3	4.3
Music: 40	1.5	–	2.6	3.1	4.7
Music: 60	2.3	2.1	–	3.5	4.1
Music: 80	3.6	3.3	3.2	–	3.7
Music: 100	4.3	3.9	3.7	4.1	–

Table 13. Mean score for "discomfort" of the advertisement part (c)

	Ads: 20	Ads: 40	Ads: 60	Ads: 80	Ads:100
Music: 20	–	1.6	2.7	3.3	3.9
Music: 40	1.7	–	2.2	3.7	4.5
Music: 60	2	1.9	–	2.7	4.4
Music: 80	3	2.4	3	–	4.2
Music: 100	4.1	4.1	3.6	3.4	–

5 Conclusion

In this study, we investigated a method to reduce the discomfort of volume change during video viewing. As a result of evaluation experiments on presented sounds, we found that linear fade-in reduced the discomfort of volume change. In particular, the effectiveness of this method was demonstrated for the intersection of music and video advertisements.

In the future we will look into other fade-in methods such as exponential fade-in. We plan to develop a system to reduce discomfort by evaluating the effects of not only volume changes but also the effects of the presence or absence of a silent interval (volume 0) and the effects of level changes in each frequency band.

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Accessibility of Buildings of Historical and Cultural Interest

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Abstract. This article presents a literary focusing on accessibility in architectural projects for historic buildings. It is an exploratory study, in which some concepts were raised regarding the area of conservation and restoration to introduce the context in which the patrimonial assets are inserted. With these definitions, the historical trajectory of the exclusion of people with disabilities or mobility difficulties by society and the development of cities was outlined. From this, the work showed the emergence and development of concepts and standards of accessibility and universal design. Then, to present two cases of architectural interventions in the city of Florianópolis (SC - Brazil), in order to bring dialogues between the new and the old and the acquisition of more access to individuals in the contemporary city.

Keywords: Accessibility · Universal design · Social inclusion · Historical buildings · Restoration

1 Introduction

This article investigates research focusing on accessibility in architectural projects for buildings considered cultural heritage. The paper aims to introduce the subject in a comprehensive approach, it is worth pointing out some concepts regarding the area of conservation and restoration. The concept of "historical heritage" is related to a good for the enjoyment of a community, constituted by the accumulation of a diversity of objects that come together around the past. Another term that guides the set of heritage practices, is the concept of "monument". Being made up of buildings built by a community of individuals, to remember events, sacrifices, rites or beliefs. The specificity of the monument owes precisely to its way of acting on memory, so that it remembers the past, making it vibrate as if it were present, however, contributing to maintain and preserve the identity of an ethnic or religious community, national, tribal or familiar [1].

Therefore, the purpose of the research is to investigate and review knowledge for a value linked to the past, connecting history in general, art history, architecture and among other areas. All of these values become a constituent part of the present experience, therefore, to maintain and perpetuate these precepts it is necessary that these monuments, especially buildings, have a frequent use, as far as possible.

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 224–231, 2022.
https://doi.org/10.1007/978-3-030-85540-6_29

Therefore, the use of historic buildings is a way of preserving and maintaining them, considering that preventive conservation can be carried out periodically, due to the daily use of the building. However, the new uses of architecture express the culture of societies in the first instance. Because of this, the original use of the built property is no longer compatible with the needs of society, since architecture is constituted as a response to the demands of such communities, therefore, it is very important to adapt these spaces. Within these adaptations, questions regarding the characteristics of environmental comfort, ergonomics and accessibility are inserted for its new users [2].

Based on this reality, this work aims to focus on highlighting accessibility in protected heritage assets, mainly due to the difficulty in reconciling the laws that deal with heritage in relation to accessibility. Emphasizing the importance of understanding that these buildings arose at different times and must be experienced by humanity, making them accessible to everyone and part of anyone's family universe [1].

2 Architecture as a Division of Citizenship

The historical trajectory has always marginalized disabled people, being victims of exclusion provided by society. This can be seen from urban spaces and traditional architectural parties, which today correspond to the built heritage. In order to talk about society and its cultural assets, it is important to mention the work "History of art as history of the city" by the historian and critic Giulio Carlo Argan [3].

Argan in his book conceptualizes that the urban space is, par excellence, the space of art, since it is impossible to think about the city and art without reference to images, temples, cathedrals or monuments. With this, the city is seen as an artistic product of its own, that is, even the rural space is a complementary space to the urban space. This goes back to the walls and gates of the old medieval cities, which did not constitute a separation of two antagonistic universes, the rural and the city, but rather the political value of the medieval city states [3].

The walls that protected the cities, also demonstrated the status of citizens and mainly, those who were protected by the city's military forces, making a social division between the inhabitant of the city protected by walls, of the inhabitants of unprotected villages. From this, the notions of city and citizenship are associated with ideas of walls, fortifications, divisions and barriers, of which architecture uses many elements to demonstrate such meanings within society [4].

Many of these architectural elements today constitute heritage properties of high cultural value and which were not designed for social inclusion and the participation of people in society in conditions of equality and without discrimination. It is worth noting that only for about 20 years, accessibility has been mandatory in architectural projects and urban interventions in Brazil [5].

In addition to presenting a recent standardization, the listed goods have some characteristics that hinder their adequacy, since article 17 of Decree-Law no. 25/1937 orders that "the listed things may not, under any circumstances, be destroyed, demolished or mutilated, nor, without prior special authorization from the National Historical and Artistic Heritage Service, be repaired, painted or restored" [6].

These listed buildings that present a series of restrictions in relation to the modifications of their structures, had to establish new guidelines for the adaptation of the

properties, in order to guarantee opportunities for people with disabilities, to know and enjoy these goods, but still respecting the premises of the conservation and restoration area [7].

As we can see, the projects for the adaptation of listed buildings are recent regulations, mainly in Brazil, due to citizenship being developed from architectural and urbanistic parties, which did not prioritize conditions of equality. The new solutions for social development, provides for more access to the listed properties, in compliance with specific legislation regarding accessibility, but also addressing issues related to the conservation of buildings of cultural interest.

3 Universal Design as a Paradigm Shift

The accessibility issues that are being discussed in this work, became relevant after the advent of the great world wars, mainly after the Second World War, from Korea, Vietnam and the Middle East. They brought changes between governments and the United Nations (UN), to allow the inclusion of the military and civilians with sequelae and mutilations due to conflicts [8].

This attitude of social inclusion has undergone international recognition, since then, in 1970 the UN promoted the concept of "Free Design of Barriers". In which the first accessibility guidelines for people with disabilities were published, published by the International Organization for Standardization (ISO). These accessibility guidelines have become widespread in Europe, the United States and Japan [9].

During this period, accessibility took into account buildings, public roads and education and work conditions. All of them based on results of science, technology and experience to obtain benefits to the community. In Brazil, accessibility began in 1981, with the creation of the International Year of People with Disabilities by the UN. In this context, the first technical standard, NBR 9050: 1985 of the Brazilian Association of Technical Standards (ABNT), emerged. Thus, the history of accessibility shows the concern with the inclusion of people with disabilities in society, through the elimination of architectural barriers and changes in attitudes [8].

From this context of international social inclusion, the development of architectural, urban and product projects began to take universal design into account. This concept was first used in the United States in 1987, by architect Ron Mace. It influenced a paradigm shift in architectural and design projects, using universal design as a way to reach a larger number of users, to avoid the need for special environments and products for people with disabilities. With this, it ensures that all people can safely and autonomously use the various objects and spaces built [10].

The way of thinking about projects for the largest possible number of users, led Mace and other researchers to deepen their investigations. As a result of their research, they proposed seven principles and guidelines for universal design, expressed as follows: equitable use, flexibility of use, simple and intuitive use, information that is easy to perceive, error tolerance, low physical effort and the dimensioning of spaces for access and use for all users [8].

From the survey of the concepts and principles of universal design, the objective of this project design becomes clear. Therefore, it seeks to simplify the daily actions of all

people, with environments, objects and communications that can be used by the whole society, without necessarily needing extra cost and adaptations.

Finally, this context outlined with the new norms and government policies for social inclusion, together with the essence of universal design, seeks to implement a fair design of projects that meet the functions and needs of all people. It increases the removal of barriers, which prevent citizens with some type of disability or reduced mobility, to participate in an equitable manner, such as those who are not disabled.

4 Expansion of Access to Historic Buildings

As it was possible to understand until now, the questions related to spaces and architecture are changing over time, and such changes occur as a result of the needs imposed by societies. However, the history of the old buildings and monuments shows constant changes in their spaces, functions and uses. Different political, religious, economic and social regimes are changed, but these buildings survive different civilizations. As a result, the practice of architectural projects adapting the built heritage is intertwined with the evolution of preservation and intervention practices [11].

The evolution of heritage preservation and intervention practices were developed from the Industrial Revolution in 1760 and the French Revolution in 1789. The increment process, from these two historical events, led to the development of the universal dimension of the concept of monument contributing to the establishment of laws, aiming at the protection of historic buildings, but also, theories and fundamental concepts for the discipline of conservation and restoration.

In addition to classic theories with their theorists, the concept of heritage has evolved worldwide, mainly from the result of periodic meetings, congresses and seminars that aimed to clarify, contextualize, give guidelines or recommendations regarding modifications and restoration interventions. With this, the so-called patrimonial letters are elaborated, which do not pretend to be a theoretical system developed in an extensive and rigorous manner [12].

In this sense, it has been registered in numerous documents and conferences of the International Council for Monuments and Sites (ICOMOS), that the conservation of the listed buildings must have as a base element their use, with this, an adaptation to the new realities and needs of the city. society. This item, referring to its use, can be observed both in art. 5 of the Venice Charter, as in art. 21 of the Charter of Burra, in which they indicate, which adaptations are necessary and acceptable, but they must have a minimal impact on the cultural significance of the place [4].

These international normative panoramas based on patrimonial charts, are also developed in the Brazilian national territory, with laws and regulations regarding modifications to develop accessibility in buildings or properties declared to be assets of cultural interest or of historical-artistic value. These new normative parameters, direct interventions in historic buildings to meet the concept of universal design, thus promoting access to the widest variety of people with different anthropometric and sensory characteristics, in an autonomous, safe and comfortable way [4].

In view of the regulations and context presented, it is worth highlighting two restoration interventions carried out in Florianópolis, in recent years, which developed proposals

for architectural adaptations to accommodate the new needs of society, and also bring contemporary debates on the coexistence of the new and the old.

The first case selected is the building of the old Town Hall and Jail, now Dias Velho Palace. The space will in the future house the Museum of the History of the City. This aforementioned building was built between the years 1771 and 1780, within the colonial logic. Over time, however, it has undergone architectural, decorative and usage changes. The property belongs to the municipality of Florianópolis and is listed, both individually and as part of the group called Historic Center (Fig. 1) [13].

The restoration of the big house included the restoration of the roof, the internal and external masonry cladding, ornaments, frames, ceilings, floors and murals. In addition, new hydraulic and electrical installations were included, installation of an ecologically correct VRF air conditioning system, security cameras, fire prevention system, installation of accessibility elements and finally, the construction of an extension and support unit, attached to the building, with elevator [14].



Fig. 1. Building of the Old Chamber and House of the Chair in Florianópolis (SC - Brazil). Construction of a volume attached to the historic building, with contemporary materials and construction methods and connected by a glass walkway with an elevator.

The second case presented is the building of the old house of the painter Victor Meirelles de Lima. It currently houses the Victor Meirelles Museum, which is dedicated to preserving the painter's memory and work, a reference of Brazilian romanticism. The loft was built in 1832, with typical characteristics of the Portuguese-Brazilian civil architecture of the 18th century, with a ground floor dedicated to commerce and the upper floor to the residence. The building was acquired by the Union in 1946 and was listed as a national heritage site in 1950 [15].

The building restoration work included archeology work, roof restoration, internal and external masonry coverings, frames, ceilings and floors. In addition, the museum underwent general improvements, such as: air conditioning, new lighting and implementation of accessibility and security conditions. The project also included the integration of the Portuguese-Brazilian loft, which houses the museum, to the adjacent building from

the sixties, it is also part of its areas, serving as extension and support with administrative and technical services. The union of the two buildings took place from the installation of an attached volume, equipped with an elevator (Fig. 2) [16].



Fig. 2. Views of the Victor Meirelles Museum building after intervention and the new volume attached to the historic building, with contemporary materials and methods.

The two intervention projects presented, bring the emerging need for the metamorphosis of heritage in view of the context and requirements of contemporary society. With a commitment to developing adaptations between new and old buildings, in order to cover the specificities and multisectorialities of each historical asset. As a result, the architectural adaptation proposals must take into account some criteria, such as: the contrast with the architectural standards of the protected and recent buildings, the reversibility of the measures, the low impact of the adaptation in relation to the entire work and the attendance to the greatest number of people with different anthropometric factors.

Finally, the manipulation of construction materials in the presented restoration, expansion and reuse projects, assume fundamental roles, as they highlight the architect's own intentions in view of the need to modify the existing one. From this need, a new language arises from contemporary materials, with the insertion of new volumes, elevators, the use of metallic and glass structures. These design parties become more than a mere differentiation between what is new and what is old, but rather a dialogue between the different times of construction, which comprise the original, the traces and the current intervention.

5 Final Considerations

In the course of this work, the trajectory of social development of inclusion was pointed out over the years in society. The city-dwelling individual has not always been able to fully enjoy his rights, especially the right to culture and property. Because they are often buildings that were designed in other social contexts, in which the inclusion and participation of people in society in conditions of equality and without discrimination

were not considered. Unlike this context, contemporaneity seeks to understand, discuss, plan and apply accessibility. Fundamental factor, to advance the inclusion of Brazilian cities and their historic buildings. However, interventions are still needed to eradicate the exclusion of people with disabilities or reduced mobility, so as to promote an approach and belonging in relation to the cultural and leisure spaces of the cultural heritage, which they wish to attend.

Although there are laws at the federal, state and municipal levels, there is a lack of practices to develop more projects or adaptations in built historic spaces, which allow access and use by all citizens. However, the projects presented in this work show that interventions for the revitalization of buildings of historical interest, end up allowing more access, and with that extrapolating the limits of inclusion, for acting as an instrument of recovery of these degraded central areas. Thus, they act as strategies for the recovery of areas that were condemned to abandonment, making city beings belonging and even included the notions of city and citizenship, foreseen in the universal design and in the space of the contemporary city.

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Active Ageing and Public Space. A Sustainable Model to Make Cities More Age-Friendly

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Abstract. In March 2020 the world health organization declared covid-19 as a global pandemic. As a result, many states have adopted social measures to prevent the transmission of the virus (quarantine and self-isolation, closure of schools and businesses, social distancing, etc.). In the short term, this resulted in a reduction in the transmission of the virus but also a negative impact on human society (on lifestyle, social relationships, psycho-physical well-being). In the long term, this social restriction can lead to change in how people can be active and a new global health pandemic: physical inactivity and sedentary lifestyles. The fact the government's rules include daily exercise outside shows how important they believe it is for people. Because physical activity and a sedentary lifestyle have consequences on the increase in the risk of cardiovascular disease, diabetes, obesity (for the whole population) and pathological ageing or with disabilities (for the elderly population which constitutes a large part of the total population), it is important to start thinking about the roles and duties of public spaces and how we can change them for the next phase of the pandemic and a more sustainable future. It is therefore a matter of placing the user at the centre in terms of its variability, whose interaction with the built environment is physical, cognitive-sensory and social.

Keywords: Urban health · Ageing · Human-centered design · Older people · Walkable space · Public space

1 Introduction

The current health crises – Covid-19 and the consequent increase in physical inactivity and sedentary behaviours – have recently awakened interest in environmental design and its potential contribution to health. The COVID-19 crisis has brought with it or has exasperated a whole selection of other problems already underway, beyond those not directly related to the virus, but to the lockdown measures (quarantine and self-isolation, closure of schools and businesses, social distancing, etc.) which have been put in place across the globe. Indeed, while of a different nature, the world has been living with another pandemic for several years – physical inactivity (PI) and sedentary behaviour (SB) [1–4]. According to the World Health Organization, in the WHO European Region,

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 232–239, 2022.
https://doi.org/10.1007/978-3-030-85540-6_30

Physical inactivity is one of the leading risk factors for health and is estimated to attribute 10% of the total deaths (one million) per year, beyond 8.3 million disability-adjusted life-years. Moreover, estimates of the direct (health care) and indirect costs of physical inactivity (loss of economic output due to illness, disease-related work disabilities or premature death) are alarming (€ 910 million per year for a population of 10 million people) [5]. The covid-19 pandemic has certainly contributed to increasing the levels of physical inactivity due to an increase in sedentary lifestyle. Many activities/opportunities to be physically active were suspended during the pandemic. The infrastructure to be physically active (school-based physical education and athletic programs, fitness centres, outpatient rehabilitation) [6] have been closed during the COVID-19 lockdown, it has been impossible for all people to engage in even simple activities such as walking to a neighbourhood park. Although PI was defined as a pandemic in 2012, all data convincingly indicates the PI pandemic will persist long after we recover from the COVID-19 pandemic [4]. In particular, the elderly population, which has been worst affected by both the virus, more than others he suffered from the directives to practice social distancing. In fact, all these factors can affect the elderly quality of life, increasing the risk of social isolation (they older adults who have been spared from the pandemic remain stuck at home to cope with loneliness and fear) with consequences on mental health, PA patterns and sedentary time across the lifespan, as well as on mortality risk (Fig. 1).

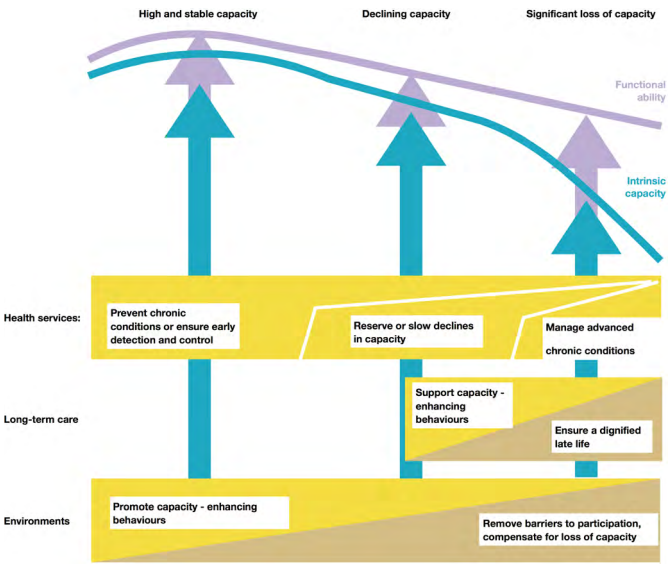


Fig. 1. Opportunities for public health activities across the life course [25].

For this reason, health researchers think that the end of the 19-Covid pandemic, we will be faced with an increase in the levels of cardiovascular diseases [7], Type 2 diabetes mellitus [8], stroke [9], metabolic syndrome [10], obesity in adults and youth [11], and at their consequences for the cost of healthcare. This prospect is of particular

concern for the population defined as "fragile" (aged 65 and over), it is the population group most exposed to the risk of the onset of serious and disabling diseases that can lead to disability and chronic conditions. The "cycle of fragility" is an interpretative model of the condition of fragility in the elderly, according to which adding the onset of diseases to the ageing process leads to a state of preliminary fragility characterized by five symptoms: fatigue, reduction of muscle strength, reduced physical activity and walking speed [12]. This condition of fragility is seen as a spiral that, in the absence of intervention, can lead to disability, comorbidity and ultimately to death. Precisely for this category of users, the physical endeavour is an essential element to stay fit and be resilient. Home incarceration among the elderly will lead to muscle deficiency (physiological and pathological sarcopenia), body overweight and disease. These changes may happen within days if immobility and laziness are apparent. This has a remarkable functional effect for or among the elderly. Active ageing (physical activity and active lifestyle) is slower in some cases and never reaches the threshold of fragility or disability of "pathological" ageing, associated with a manifest fragility, in the presence of one or more chronic degenerative diseases and disabilities [12].

2 Active Ageing and Public Space

The importance of adapted outdoor spaces for active and healthy-ageing is confirmed by growing evidence from research ("Active Aging a Policy Framework" of the United Nations, "Strategy and Action Plan for healthy ageing in Europe, 2012–2020" of the WHO European Regional Office, WHO Guidelines on Physical Activity and Sedentary Behaviour of 2020, "Age-Friendly Cities" project, The program AHA "Active and Healthy Ageing" etc.). WHO (2016) notes that open space is essential, even though they employ incidental impacts on health. Consequently, to attain healthy ageing, cultivating some newfound open space based on the elderly is vital and necessary. A significant challenge in the 21st century is to deal with the global trend of population ageing and how to incorporate the health needs of elderly into the open space development in the urban area. Urban pathways (pedestrian and cycling lanes), urban environment and urban furniture are three dimensions of the physical environment that can enable/disable the elderly in the use of urban public space. In particular, walking should be promoted among older people because there is evidence that increases moderate level physical activity are associated with longer-term changes in behaviour than those which require specialist facilities, such as sports pitches or gyms [13]. Furthermore walking is the most popular mode of transport for older people for local trips in all European countries; there is further interest in walking since it is available to young and old, rich and poor, and requires no skills or training [14]. In addition to walkable spaces, also natural environments, parks and green spaces can promote well-being and health through increased activity levels. Evidence shows that older people who live close to parks and other open spaces walk more and leave their homes more frequently [15, 16]. Design, attractiveness and the perceived safety of green places affect activity levels, improve quality of sleep [17], and enhance mood and mental health [18]. Finally, these spaces can be equipped with urban furniture that can be adapted to the functionality of the users to improve the performance of the elderly and ensure the highest possible degree of autonomy and self-sufficiency.

Moreover, make cities more age-friendly can have positive consequences, not only the health determinants of individual travellers who decide to have an active lifestyle but also for society as a whole, affecting: 1) environmental health determinants (air, pollution, presence of green areas, urban heat island) and an overall improvement in the quality of life for all residents; 2) social cohesion with people interacting on the streets while actively commuting [19]; 3) so-called "lifestyles" (walking instead of driving, using stairs instead of the elevator, socializing instead of isolation) [6]; 4) overall mobility with less car-dedicated infrastructure and more that could be replaced by green space and spaces for active mobility.

3 Elderly Based Public Space Strategies

It is therefore a matter of placing the user and design the public spaces with awareness of the needs of – and in consultation with – older people, recognizing their diversity. The goal of interventions in this domain is the promotion of physical activity not only to promote healthy ageing but also to guarantee conditions of bio-psycho-physical well-being of the general population. The research topic addresses the importance and the centrality of the Elderly-Centred Design approach in the observation of the interactions established between the user, furniture systems and urban spaces, identifying design strategies that guarantee the conditions of physical, mental and social well-being for elderly people. These interactions can be summarized as follows: Physical Interaction, Cognitive-Sensory Interaction and Social Interaction (Fig. 2).

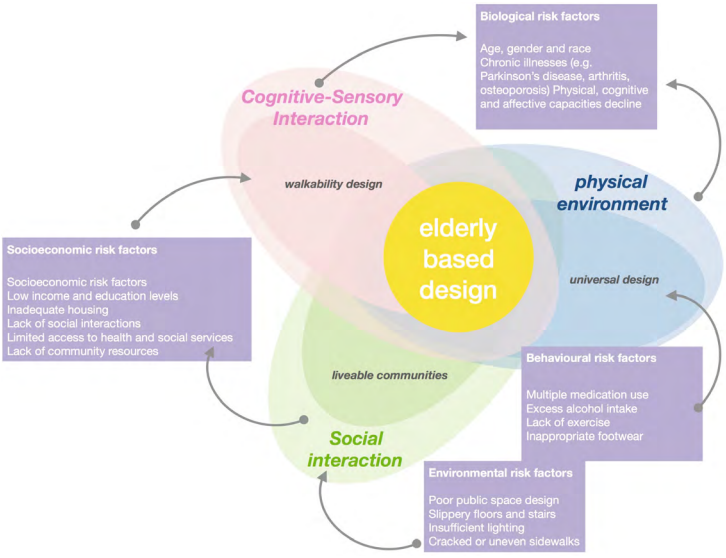


Fig. 2. Elderly based design

Physical Interaction. When the relationship is mainly of a dimensional type and is established with systems (space and objects) that it is necessary to manipulate and use through bodily contact [12]. Many elderlies do not have easy right to use parks and open spaces, which curbs their rate of recurrence of physical activity and may contribute to why they are more concerned about environmental needs than younger adults [20]. Consequently, the elderly are increasingly likely to participate in physical activity as the area of nearby open space or parks risen [21, 22]. Indeed, there is a straightforward relationship between perceived open space, park nearness and physical activity [23]. Another relationship is between the number of parks, acreage and physical activity among the elderly but not so far from their homes or area [24].

The basis of a good physical interaction are:

– barrier-free environments (retro-fitting public spaces and infrastructures to create barrier-free access to public places, routes, buildings and transport). As people get older they often experience a greater sensitivity to safety and confidence in outdoor spaces and are thereby discouraged or inhibited from going outdoors and moving around. For example, a lack or insufficient density of facilities such as benches, public toilets or elevators has been reported to discourage independent movement outdoors for older age groups [25, 26]. An age-friendly city is a structurally inclusive city that supports a barrier-free environment can make the biggest difference to people at greater risk of disability and poor health; perceptually inclusive city as it offers paths and spaces that are easily understood by all and in particular by people with sensory and cognitive disabilities; environmentally inclusive as it allows activities to be carried out in comfort conditions (shade, ventilation, sunshine). E.g. Ljubljana, Arona, Gothenburg accessible cities, Helsinki for everyone, Accessible London, Boston for All, Abu Dhabi Urban Structure Framework.
– boosting environmental confidence using techniques such as passive surveillance in collaboration with local police, friendly neighbour, initiatives to reach out to older people at risk of isolation and abuse setting and enforcing standards for newly built [25].
– creation of "20-min neighbourhoods" with key facilities within reach of older people's housing within a limited time of walking or public transportation. It is a model that describes density, diversity, proximity, ubiquity neighbourhood, where people can meet their everyday needs within a short walk or cycle. By creating well-designed walkable neighbourhoods that are connected through a mix of land-uses, housing types and access to quality public transport, we can create more healthy, liveable communities (e.g. Plan Melbourne 2017–2050, Portland's Climate Action Plan, Carlos Moreno' project for Paris, district of Nordhavn in Copenhagen).

Cognitive-Sensory Interaction. Which concerns the quality of the interaction and depends on the proportional compatibility between user-space-objects and sensorial compatibility, understood as appropriateness and coherence of the stimuli emitted by physical systems with the physiological structures of individuals [12]. Open spaces and parks should be constructed and designed regarding both the common physical failures

with age and simultaneous physical and mental diseases and disabilities. Therefore, different public space features and elements should display ergonomic and elderly-friendly designs, balancing between physical health needs and mental or emotional needs.

The basis of a good Cognitive-Sensory interaction there are:

- the infrastructure for active mobility and walkability, including creating accessible walking paths with resting points, increasing road safety, supporting safe cycling and developing accessibility standards in public transport, paths with resting points, water points and points of interest along the path, as well as pedestrian streets with good lighting [manuale] (e.g. the Diagonal Mar Park in Barcelona, 2002; the Luis Buñuel Metropolitan Water Park in Saragossa, 2008; the Superkilen Master Plan in Copenhagen with projects by Topotek 1 and Super-ex, 2012; the installation Ready. Steady. Go! in Graz, 2010);
- the installation of exercise equipment and sports equipment in public places and parks, as well as making parks more accessible/usable and safe by installing benches, lighting, fountains and shaded rest areas. These types of equipment can be conformed and adaptable to the abilities/disabilities of the users [26] (e.g. Lappset senior sport, HealhLoop gym; Capeston Fitness Park);
- olfactory, auditory and tactile stimuli. The attractiveness, the multifunctionality, the variety of these spaces influence the active use of the public space for carrying out aerobic activities. According to this vision, the propensity of public space to favour walkability depends not only on usability and on the conformative-dimensional relationship (accessible, inclusive space) but also on the capacity of the space to be an "experiential reality" (psycho-physical-metabolic relationship) and, finally, "prosthetic space" capable of stimulating decisive activities (e.g. Brooklyn Bridge Park, the garden of the five senses in Nantes, the High line of New York).

Social Interaction. Relating to the interpersonal relationships that are established between the components of a community to encourage and/or improve the usability and liveability of urban space, the possibilities of meeting talking, exchanging opinions, performing functions and leading to more active and healthy lifestyles [12].

Open space should be just for the physical training activities area and be valuable social places for gathering and socializing among the communities in that particular or respective area [27, 28]. Social aspects of open spaces are a "natural neighbourhood network" and may also increase physical activity, especially when combined with the supportive apparent and objective aspects of the environments (colmar, urban green open space).

The evidence emphasizes how vital the support that elderly people obtain from community connections and relationships could be. The decrease of isolation and loneliness displeasure may be an essential factor in the main obstacle or the recuperation procedure.

The basis of a good social interaction there are:

- elderly people's enthusiastic and active involvement in social movements in their neighbourhoods, that could be expanded via specific schemes targeted at elderly (e.g.; PARK(ing)Day Initiative, from 2005; Project Agromere in Wageningen, Sociopolis in Valencia; De Leefstraat Project);

– intergenerational spaces and activities that promote an exchange of values, skills and experiences (e.g. Intergenerational Leadership Institute of Penn State University, the international TOY Programme; The Manifesto "Intergenerationality Adds Up Lives");
– community-based initiatives to promote health and well-being (urban gardens, elderly babysitters, craft workshops etc.).

4 Conclusions

From the previous considerations it emerges that the person's ability to age well and independently depends on the relationship between own physical and mental capacity and the characteristics/barriers of their environment. According the "person–environment fit" model, coined by environmental gerontology [29], the paper attempts to identify three domains that are based on the users-environment (space and object) fit concept – physical, cognitive-sensory, social – and corresponding strategies (universal design, walkability, liveable communities) that older adults can age in place, age well and maintain independence. Supporting a city more age-friendly contributes to optimizing opportunities to promote population health over the life-course and into older age and the well-being of whole population.

Author Contributions. Conceptualization, Data curation, Investigation, C. Cellucci; Supervision, Validation, M. di Sivo. Writing—original draft, C. Cellucci; Writing—review & editing, C. Cellucci, M. di Sivo.

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Analysis of Fashion Value and Emotion in Digital Environment Based on Analysis of Famous Korean Fashion YouTube Review Data

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Abstract. The fashion world is trying various changes due to the development of technology, the non-face-to-face environment caused by Covid-19, and the lifestyle change of the digital generation. It is a world where luxury brands promote and sell their products in a metaverse environment. Fashion influencers also use YouTube to give advice on styling and short content, and lead lifestyle changes. As a result, the values and sensibility of digital-based fashion are also changing. Therefore, this thesis researched related contents through Fashion YouTube. Fashion YouTube, which has the top 5 domestic subscribers and videos as of May 2021, was selected. I crawled their youtube data reviews with python. As a result of the analysis of the collected data with text-mining, past fashion discovered fashion and trends, but modern fashion further emphasized the philosophy and values of life based on their own lifestyles. Rather than changing fashion based on trends, fashion is a means of expressing individual values, emphasizing emotional details and expressing fashion changes.

Keywords: Digital fashion · Data analysis · Python · NVIVO · Text mining

1 Introduction

Due to the 4th industrial revolution, the technology of the digital environment has developed rapidly. Also, as the non-face-to-face environment is spreading due to covid-19, the visual expression and reaction to fashion have also changed. In addition, with the advent of Generation Z, the fashion field is also changing due to adaptation to the digital environment from birth. According to the UK Stylus Report, the digital generation, Generation Z, will reach 40% of total consumers by 2020, accounting for 23.7% of the global population. They engage in various activities such as shopping and playing games with their friends in a virtual environment called the Metaverse. Communication in the digital environment has created another new lifestyle. In line with this change, fashion brands also took the lead, introducing new season clothes in the metaverse environment and connecting them to sales. In addition, as a generation that is deeply concerned about the value and authenticity of life, they have a philosophy of trust and environment in

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 240–245, 2022.
https://doi.org/10.1007/978-3-030-85540-6_31

their fashion consumption behavior. Because the value and sensibility of fashion of Generation Z, the main consumer group, is changing in the near future, this thesis intends to analyze keywords related to this through their favorite fashion YouTube channel.

2 Value and Emotion of Fashion

The true meaning of fashion is 'trend'. However, for most people, it is often identified with 'clothes'. So, the previous fashion was mainly focused on aesthetic values and was sensitive to trends. While the aesthetic function of a fashion object is to make the wearer more attractive or sometimes to be admired purely on its own terms, the most beautiful garments also perform utilitarian and social functions. The object promotes social acceptance by conveying information about the wearer. Consumers perceiving a fashion object make style-based inferences about the characteristics of the wearer, such as age, gender, status, and sexual availability [1].

A study by Wirawan (2019) investigated the lifetime value of customers related to customer segmentation based on lifestyle. Figure 1 [2] shows four customer segments with unique lifestyle patterns through customer empirical analysis.

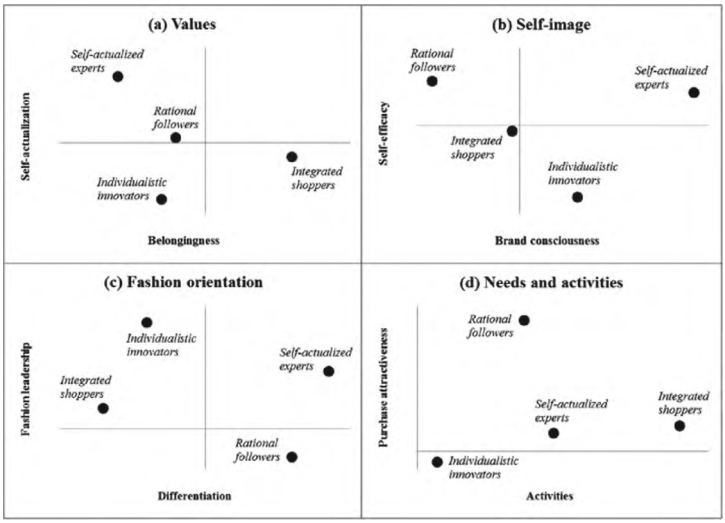


Fig. 1. Customer's segment for lifetime value

For the current Gen Z, fashion is a digital environment, and as information and knowledge are transferred faster, trust between suppliers and consumers is important, and ethical values and social responsibility are added. For the current digital generation, the identities of 'Individual Innovators' and 'Self-actualized Experts' shown in Fig. 1 are emphasized. As a result, values and sensibility are changing, focusing on lifestyle in a broader sense beyond the aesthetic value of fashion.

3 Research Method

3.1 Research Method

In the fashion world, Korea's fashion sense and consumption are second to none compared to other advanced fashion countries. As a result, Koreans have a good sense of fashion and are sensitive to trends in society as a whole. In the digital environment, the internet speed is very fast, so consumption in the fashion e-commerce market is very active. In this friendly digital environment, people also get help with fashion information and styling advice through YouTube. Therefore, among Korean fashion video YouTubes, I studied lifestyle and clothes-oriented styling videos. This study investigated the keywords that Koreans mention about fashion in related fashion videos to analyze the changing values and sensibility of fashion.

3.2 Data Analysis

Based on lifestyle and fashion styling, we collected data by selecting top 5 fashion YouTubers in Korea by considering subscribers and applications. The five fashion YouTubers selected through a domestic YouTube statistics collection platform called 'Vling' are shown in Table 1.

Table 1. Font top 5 list of fashion YouTube in Rep. of Korea

	YouTube	Concept	Subscriber	Video	View	Average view	Link
1	Milanonna	fashion, lifestyle	81.2 M	73	1.6 M	38.9 M	https://www.youtube.com/channel/UCXXlcPH1stsP3VwYG90s4wg
2	Kkang Stylist	fashion styling, beauty, lifestyle	76.8 M	620	27.4 M	18.7 M	https://www.youtube.com/channel/UC8a6z7i9qypp9PqJ_0HhBrw
3	Director, Jjang-gu Daddy	fashion styling	54.6 M	1651	8.8 M	7.4 M	https://www.youtube.com/channel/UCcSepD5GRKpskptBW2TSKGg
4	Style Guide, Choiwinter	fashion styling	50.3 M	770	3.9 M	6.0 M	https://www.youtube.com/channel/UCbOwqHbQf0uspeRe7lY8e6Q
5	Jjunglish Fashionlife	fashion, lifestyle	37.9 M	1413	8.8 M	4.2 M	https://www.youtube.com/channel/UCexnMWt_GyyAlkLCn7x36nw

3.3 Data Crawling

I selected the top-viewed videos for each of the five fashion YouTubers. And I used Python to crawl the comments of the video Fig. 2. Coding process for crawling data. All video data were crawled in the following format.

```python
from selenium import webdriver
import time
from bs4 import BeautifulSoup
import pandas as pd

driver = webdriver.Chrome()
driver.get("https://www.youtube.com/watch?v=qcX2Pflw9cY")
driver.implicitly_wait(50)
time.sleep(50)

box = []

last_page_height = driver.execute_script("return document.documentElement.scrollHeight")
while True:
    driver.execute_script("window.scrollTo(0, document.documentElement.scrollHeight);")
    time.sleep(50)
    new_page_height = driver.execute_script("return document.documentElement.scrollHeight")
    if new_page_height == last_page_height:
        break
    last_page_height = new_page_height

    source = driver.page_source
    html = BeautifulSoup(source, 'lxml')

    reviews = html.select('#content-text')

    for i in reviews:
        if i.text not in box:
            box.append(i.text)
    print('{}개 댓글 저장완료'.format(len(box)))

    df = pd.DataFrame({
        '댓글' : box
    })

    try:
        df.to_excel('result-milla_wardrobe.xlsx')
    except:
        pass

driver.close()
```

Fig. 2. Coding process of data for YouTube reviews

3.4 Text Mining

As a result of text mining by collecting all comments, primary keywords as shown in Table 2. The result is to extract up to 1000 of the most mentioned keywords among the keywords. Among them, meaningless prepositions, adverb phrases, and onomatopoeia were excluded.

Table 2. Primary extraction keywords of text mining

love, recommendation, fashion, restriction, clothes, subscribe, trousers, put on, age, date, handsome, luxury brands, people, look, life, legs, belt, beautiful, shop, everybody, feel, manner, looks good, figure, space, woman, authenticity, granny, always, goals, lady, sharing, taste, chic, care, man, resemble, body, envy, proportion, style, teach, timeless, jacket, information, young, contents, coordinates, jean, force, edge, afford, inspiration, learn, awesome, gorgeous, etc.

By text mining the above keywords, the meanings related to important keywords related to fashion were analyzed. Text Search Query was executed using Qualitative Data Analysis Software called NVIVO. Among the analysis results, ‘Fashion’, ‘Clothes’, ‘Wish to be’, and ‘Looks good’ contained the most in-depth content and meaning.

First, the meaning and relevance of the keyword ‘fashion’ can be seen through Fig. 3. Basically, people wanted fashion sense and fashion styling through good-looking designs

and fabrics. And he wanted to change his appearance by consulting people with abilities. However, they wanted a fashion that was not too influenced by the times and trends rather than simply pursuing aesthetics. In the meaning of words that contain keywords, they show that they want fashion that harmonizes with lifestyle wisely and elegantly even when they get older.

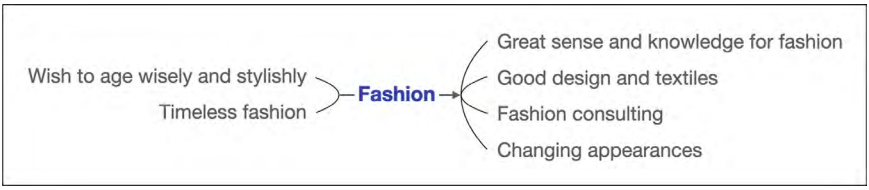


Fig. 3. Text search query about 'fashion'

Second, 'clothes' is the most representative keyword in fashion. Since people equate fashion with clothes, we looked for the meanings of 'clothes'. Here, too, similar meanings to the keyword fashion were seen. There were body shape management for clothes and ways to wear them well, but there were concerns about clothes that can be worn for a long time in a progressive sense and the image shown through clothes to people. He wanted to keep the precious new clothes he bought always in good condition and to wear them for a long time (Fig. 4).

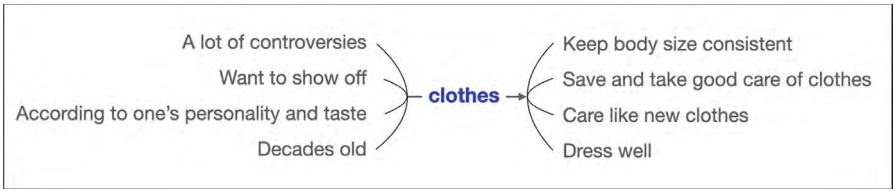


Fig. 4. Text search query about 'clothes'

Third, the meaning of 'Looks good' contained the meaning of identity shown to people through fashion. To express their identity, people discussed the importance of lifestyle, attitude, and value of luxury brands. He wanted to be a luxury item with an elegant and cool attitude. Through classic items, he pursued a fashion that fits his identity and lifestyle rather than a fashion style that changes easily according to trends (Fig. 5).

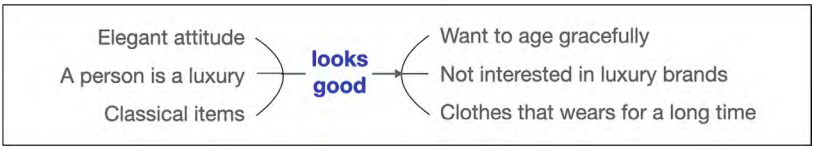


Fig. 5. Text search query about 'looks good'

Fourth, 'Wish to be' is a discussion about how people want to organize their lifestyle through the keyword of fashion. They express their identity through fashion and create their own lifestyle. The keywords in Fig. 6 show the meaning of how to achieve the value and style of life you seek. People live passionately for their successful lives and want to become experts in their field. And they believed that these thoughts would help them get rid of their fear of growing old and become great seniors.

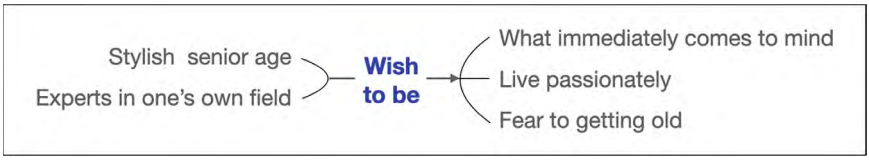


Fig. 6. Text search query about 'Wish to be'

4 Conclusion

As can be seen from the data analysis results of this study, fashion has undergone many changes due to the digital environment and non-face-to-face environment. People who have broken the boundaries of online and offline have made a big change in their attitude toward fashion and consumption. In the past, they used fashion to satisfy their desire for aesthetic expression and show off. However, for the current digital generation, including Generation Z, fashion is a way of expressing their identity and communicating their lifestyle. For them, fashion was a means of organizing their lifestyle in order to age gracefully. In this way, they changed the value and sensibility of fashion. In order to express through fashion how he lived passionately and became an expert in his field, he paid more attention to classic sensibility and ethical values in order to age gracefully. This study will serve as a cornerstone for studying the change of fashion in the rapidly changing digital environment of the future. Future research requires a developmental and integrated thinking about the meaning and sensibility of fashion changed between generations and the factors that influence each other.

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Interface Design for Offline Learning

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Abstract. This paper focuses on the design and evaluation of an educational solution centered on environments that do not have internet access. Two different prototypes were evaluated, one focused on creating the class content aimed at teachers, and the other focused on displaying and using the class content aimed at students. For this, twenty teachers and ten students were reached from African and Asian countries where the network conditions are not proper for remote educational environments. Preliminary results state that the participants were favorable to these solutions.

Keywords: Human computer interaction · Education · Interface design

1 Introduction

With the rise of digital technologies, new teaching methods were developed to bring more practical and advanced education materials to the learners' hands and more straightforward tools for the teachers. These tools are put to the test when educational activities change forcibly in case of a catastrophe. With the latest pandemic, governments were forced to adopt new methodologies so students could continue to learn without risking their health. Most of the solutions were possible with the use of video calling between students and their teachers. In cases where distance learning is inexistent or even impossible, the students are left alone. This situation is recurrent in developing countries, where most educational activity is presential, and the learning activity depends entirely on the teacher. With new technologies, the educational activity can and should adapt to bring the school to the student's homes and make the learning activity as autonomous as possible if the students cannot meet their teachers.

With this in mind, the idea of a mobile application that tries to solve these issues arose that should work offline on mobile devices, to provide equitable and non-discriminatory education. For that, a particular approach had to be made to contact, understand, and communicate with people from regions more affected by this issue.

This paper includes four sections besides the introduction. The first section is dedicated to a literature review of previous work done in this area. Section 2 explains the concept behind this solution, what it requires, and how it is designed to work. In Sect. 3, the steps and procedures to evaluate the prototypes are explained, including the results of the experiments. Conclusions and future work can be found in the last section.

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 246–254, 2022.
https://doi.org/10.1007/978-3-030-85540-6_32

2 Literature Review

Mobile learning is part of the last generations of distance learning due to the new realities of the modern world's technologies. In countries such as Nigeria, governments have already tried out some procedures on distance learning related to nomadic groups such as "Literacy by radio," mobile schools, which could be instantly assembled, and TV/radio education [1]. It concludes that radios are way more affordable, accessible, and handier than televisions, but that education organizations in these countries should make the correct approach with mobile devices. Since the app design focuses on people in conditions where internet connection is scarce, nomadic populations should also use it. The authors also point out mobile education challenges for migratory communities. The challenges identified were:

- The risk that nomad populations might not want to embrace such solutions.
- The cost related to these kinds of solutions.
- The monitoring and evaluation of the educational program that would require non-governmental and community-based organizations to act.

Mobile phones are widely used in informal education since phones are not allowed during school hours [2]. We use them to call colleagues and friends to see if they can help us or help them reciprocally, to see their problem-solving knowledge. The research results concluded that:

- Mobile phones work pretty well as tools of the learning process's aid since while teachers could focus on the learning process, the learners were very open to using this kind of technology.
- A mobile audio encyclopedia is of immense interest in African learners' case since access to paper is limited, and there's a strong African oral tradition.

Mobile learning offers learners the best practical way to access information. The FRAME model (Framework for the Rational Analysis of Mobile Education) [3] design takes full advantage of the features to implement when designing for these mobile learning experiences. It takes into consideration various aspects related to social and personal aspects of learning and psychological theories. Mobile devices are considered as active components both to learn and other social processes in this model.

Mobile learning solutions as a form of education have been used by already quite some time even though most of the solutions found are made for online learning. According to UNESCO, in the learning solutions for education response for Covid 19, in the section of Systems with strong offline functionality, there are three different solutions: Kolibri, Rumie and Ustad Mobile [4].

Even though the methods differ in terms of technologies, the content format is the same in all of these apps: a library that accesses content in different modules. These applications' user experience relies on the content, not on creating a user routine or companion.

3 Offline Learning App

Typically, in distance learning, the digital solutions that exist primarily depend on the real-time online connection between teachers and students. This online connection is established using applications like Moodle or Microsoft Teams and video-calling solutions like Zoom, or Google meets. Real-time solutions that do not require internet access are television and radio. The problem is that learning, in this situation, requires the students and the teachers to establish a contact in the same schedule, using the same tools, and, implying that the students have access to those same tools. If students do not have access to the internet, contact with the classroom is easily lost.

3.1 Architecture

In order to attempt to solve this problem, the solution formulated resulted in an app ecosystem that allows sharing educational content offline, using long-distance file-sharing technologies, such as Bluetooth, NFC, or Wifi Direct. It relies on a peer-to-peer architecture where each peer shares content stored in its memory after the creation of class content in the teacher's app.

The experience relies upon three fundamental events:

1. **Content Creation:** The teacher inputs the information and content for his students to learn inside the teacher's app. The compilation of this information will result in an exported file that contains the learning content and informs the relationship between the content and the UI elements, such as an XML or JSON file.
2. **Content Sharing:** After the first step, the teacher can now share the compiled file. To share between devices without needing mobile data, the files can be shared via NFC, Bluetooth, Wifi Hotspot, or even Android nearby share. This process can also be done between students, sharing the file with the teacher's content without being by his side.
3. **Content Parsing:** When the content reaches the destined device, it is now parsed to transform the received file in the correspondent UI elements with the teacher's content. The content shows in the order and format intended by the teacher (Fig. 1).

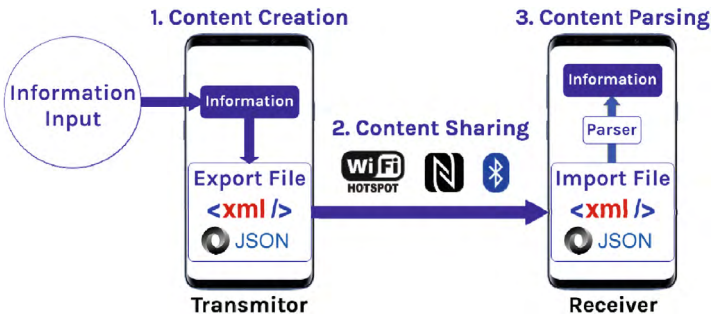


Fig. 1. Architecture model

3.2 Requirements

Since the work is divided into two different and separate apps, different procedures were applied to create the apps requirements lists, one for the teachers and one for the students. The teacher's app requirements relied on the learning app requirements, and so, since it was impossible to contact students directly due to the lack of contacts and communication channels, the student's app requirements rely on the FRAME model, which examines the design for mobile learning experiences. The FRAME model includes several questions that lead us to a list of requirements, from where the most important to evaluate were (Table 1):

Table 1. Student's app key requirements

KR	Key requirements	Priority
	As a student I would like to	
KR-1	View the different lessons to complete	High
KR-2	Solve lesson's exercises	High
KR-3	Visualize lesson's progress	High
KR-4	Have access to past lessons content	High
KR-5	Have access to my personal area	High
KR-6	Send my lessons with other students	High

To validate these requirements, there was a need to know what the teachers thought about this app since they would have to create content for it in their app. With that in mind, ten schools were contacted through international phone calls to know if there were teachers available to be interviewed about this app. From all the schools contacted, two were able to schedule interview sessions. To fulfill all the study cycles, later, a university professor from Timor East also was interviewed. The interviews were composed of closed and open questions, the closed ones related to the demographical reality of the interviewees, and the open ones linked to opinions, ideas, and feelings about these apps. Of the 20 teachers contacted, fifteen were from Guinea Bissau, four were from Cape Verde, and one was from Timor East. Fourteen teachers had a smartphone, and twelve had internet access, but only the university teacher had internet access in the workplace.

The interviews demonstrated overall very positive reception from the teacher's side of the app's idea, and with the suggestions and ideas that surged during the open questions and based on the requirements of the student's app, the requirements to evaluate in the teacher's app were (Table 2):

With these requirements and three personas inspired by the teachers contacted and their school environments, wireframes and prototypes were created to evaluate each of the apps. On the conversion from wireframes to prototypes, some accessibility decisions were considered, such as avoiding scrolling and using a typeface in the student's app that made reading easier for students who might have dyslexia. With the prototypes ready, the next big challenge was evaluating them.

Table 2. Teacher's app key requirements

KR	Key requirements	Priority
	As a teacher I would like to	
KR-1	Create a new lesson	High
KR-2	Create content inside a lesson	High
KR-3	Edit content	High
KR-4	Have access to my personal area	High
KR-5	Send my lessons to students	High

4 Evaluation

Since the first contact made was with the teachers, in order for them to test with their students, the best way to introduce these apps to them relied on examining if they had an enjoyable experience testing the prototypes. So before trying to test with students, first, their teachers would be contacted. Because the ways to communicate with the teachers were limited, the evaluation had to consider the different possible scenarios that we could encounter. In the interviews, near the end, the teachers were invited to keep in contact via email or WhatsApp. These ways of contact do not rely on making costly phone calls. After the prototypes were finished, at the end of the design phase, the teachers who provided their contact were then invited to evaluate the prototypes. Out of the six contacts available, four showed availability to test, one did not answer, and one informed that the usability test could not be done since his internet data plan was about to cease. One of the teachers talked about the experience with some co-workers and shared their contacts since they showed interest in also participating in using the prototypes. With that, seven teachers participated in the evaluation phase.

Maze was used to conduct the experiments. Maze is a platform used to perform usability tests remotely based in a task-oriented environment, and was chosen since it registers the users' paths and where (mis)clicks happened. Moreover, it can record the participants' performance when interacting with the interfaces.

Following scheduling the sessions, a call was made via WhatsApp to check in what format the test would be done. At the beginning of each call, it would be settled if the participants were available at the moment to test, and a link to perform it would be sent in a message. During the call, the participants would be asked to open the link and tell what they saw on the screen in order to troubleshoot if necessary. This way, the loading times would show how good was the connection, and if the connection was not suitable enough to load the project, the test would have to be made indirectly since the user would not be able to interact directly with the prototype. If it had to be an indirect test due to an unstable connection, the participants would be asked if the connection was limited and if they could perform the test in Facebook Messenger. Facebook messenger was also used since, on the video calls option, there is a functionality that allows screen sharing, making the test more comfortable and reliable. If the participants had a limited data plan, the test would be done in a video call, where the phone back camera would

display what was on the computer screen, in portrait mode to show the content on the same proportion as on the video call screen (Fig. 2).

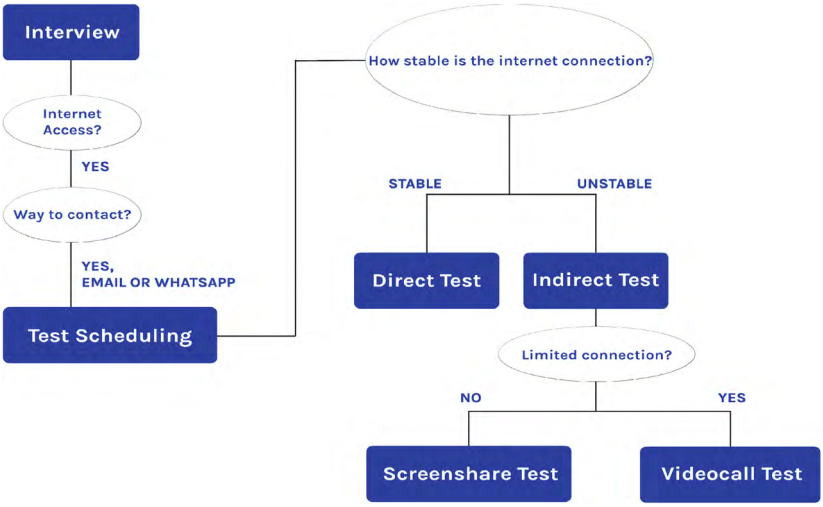


Fig. 2. Testing methodology

Below the different types of tests, their pros and cons are described (Table 3).

Table 3. Test methods comparison

Test type	Pros	Cons
Direct	The participants interacted directly and experienced by themselves the prototype Using Maze, it is easy to see where the participant clicked and how they interacted with the prototype Results more realistic in terms of real-time usage by the users on the first time The participants tested the prototype on their own devices, being more manageable to know the device's controls and limitations	Require a stable and decent connection to the internet to test Loading times while using the prototype might have slight changes due to the internet usage to make the call. Moreover, the exact opposite correlation happened since the internet usage on the prototype affected the call quality Not possible to watch the facial expressions of the participants

(*continued*)

Table 3. (*continued*)

Test type	Pros	Cons
Screen Share	Shorter loading times since opening the experience relied on the facilitator device Less usage of participants' device multitasking since only one app was needed to view the interfaces, which also affects the internet usage on the device, being possible to have better streaming resolution and quality	The facilitator is more involved than in the direct test method by clicking on the interface instead of watching the participant's performance Less immersive experience compared to direct testing
Video Call	It needs even fewer resources on the facilitator's device than the screen sharing method since the device that's being recorded is the one that needs to open the experience The capability of zooming in on the elements, in case of poor readability, is possible and helpful in case the internet signal is weak, and the image quality on the participant's device is not the best It is the most straightforward method since it only relies upon using the same app for the initial call	It might be challenging to record steadily in case a tripod is not used on the facilitator's side Bad screen scaling, since it depends on the facilitator's camera proportion The facilitator is even more involved in the experience since there is a need to know if the interfaces display correctly on the participant's side The least immersive experience of the methods, since the display of the interfaces is the least closed to the prototype look on the participant's device

4.1 Teacher's App

The participants were tested on the teacher's app to see how they created content inside the app and navigate it. Since the participants already previously used their mobile devices and could comfortably express what they were thinking, they were invited to perform seven different tasks in the prototype (Table 4):

At the end of the seven tasks, the teachers were also asked how much they liked the experience using a smiley scale. All of these tasks were performed while on call, with a facilitator troubleshooting and helping the participants.

The results from this evaluation showed that from task 3 to 5, since they relied on the same controls, the users' performance got more efficient. Other observations made on Maze [5] showed that on the first task, two participant, instead of saving the lesson empty, created at least one exercise before saving the lesson.

Every participant reported the sessions as an overall very positive experience.

4.2 Student's App

The student's app turned out to be the biggest challenge to test since it would require:

– stable connection to perform the test in Maze directly

Table 4. Teacher's app test result

Task	Description	Success rate	Average time
1	Create and save lesson	100%	2:00
2	Create a multiple choice question and save	100%	1:34
3	Edit solution from exercise 1 to answer 2	100%	3:10
4	Duplicate exercise 1	100%	1:00
5	Delete copy of exercise 1	100%	0:30
6	Edit profile information	100%	1:17
7	Send lesson 1	100%	1:12

– a device to test all the students
– teachers availability to troubleshoot eventual problems and be a possible facilitator

Two teachers who performed the direct test showed steady internet connection and were invited to perform the activity with their students in class. The two teachers showed interest in this activity, but only one performed the tests in the end since the other one had calendar issues that would not make the experience possible.

For the student's app, the number of tasks and complexity had to be as short and straightforward as possible, since the network conditions inside schools would be impossible to control, it should not count with much supervision, and info literacy from the side of the students was unknown.

With that in mind, the number of tasks considerer was half of the max supported by Maze [6]: five tasks. The five tasks evaluated navigation, controls, and functionalities (Table 5):

Table 5. Student's app test result

Task	Description	Success rate	Average time
1	Begin math lesson	100%	0:16
2	Start lesson, answer question and continue	100%	0:08
3	Open the notes	100%	0:12
4	See the history lessons that are in the library	100%	0:06
5	Share and send lessons	100%	0:07

All of the students expressed maximum satisfaction to this experience. Even though there was no direct contact with the students, their teacher expressed that they liked it a lot and even wanted to repeat the experiment.

5 Conclusions

Despite technology being ever more ubiquitous, there are still those who lack proper access to the online content, especially in education. In this work, two prototype apps were developed in order to facilitate offline access to educational content. The prototypes were tested both with students and teachers of places where these conditions can be verified.

With the results analysis, it can be inferred that this app ecosystem would be appreciated as a digital solution for people who live in these conditions. Future work would include experimenting different educational areas such as arts and physical education.

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A Selfish Chatbot Still Does not Win in the Ultimatum Game

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Abstract. In this study we aim to observe if intentions are conveyed by a relevant conversational context in a chatbot interface and if it influences decision-making. We created two conditions using the alternate counter-offer version of the ultimatum game in 2 negotiation settings: face-to-face and through a chatbot. There are two inter-locutors: the proposer and the respondent. The proposer must share 10 units with the respondent. If the respondent accepts the units are shared while everyone loses if the respondent refuses. 92 participants took part in this study: 62 in the chat-bot condition and 30 in the face-to-face condition. Participants faced three player profiles: stochastic, selfish, and rational. Results show that participants decrease the value of the offer more easily in the chatbot condition with the selfish profile. We conclude that the intentions are correctly conveyed by the profiles even in a chatbot-like negotiation despite the absence of non-verbal behaviors.

Keywords: Ultimatum game · Pragmatics · Reasoning · Human-machine interaction · Contextual clues

1 Introduction

The ultimatum game [1] illustrates the final phase in a negotiation between two entities represented by two players A and B. Player A offers player B a share of the units belonging to them (usually 10 units), and Player B can either accept or refuse their offer. If B accepts the offer, the units are exchanged between the two players. If they refuse instead, the two players lose all the units (all 10 of them, regardless of the amount that was proposed to be shared). In a second turn of the game, it is player B who makes an offer to player A. From an economic rationality point of view, the responder should always accept the offer even if it is minimal (if they are only given one unit). However, the large number of experiments on the ultimatum game indicates that offers corresponding to a fair share (4, 5 units) are widely accepted while minimal offers (those below 3 units) are very often rejected [see 2 for a review]. Individuals are sensitive to inequalities towards themselves and towards others in their decision-making. Some parameters seem to mitigate these results. For example, if the proposer is strongly constrained to make an unfair offer, then the respondent will also be more lenient towards them [3]. The respondent's attributions of the proposer's intentions modulate the acceptance of the

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 255–262, 2022.
https://doi.org/10.1007/978-3-030-85540-6_33

offer. It has also been shown that the offer made in the second stage by player A, who has become a proposer, depends on the offer made by player B in the first stage when economic rationality tells us it should be independent. There is reciprocity of behavior. Thus, players are willing to sacrifice their own material goods in order to reward a person judged to be fair (who has previously made a fair offer) or to punish a person judged to be unfair (who has previously made a base offer). This judgment is also modulated by attributions made about the other player's motivations and constraints, as well as by the context of the situation [4–7].

Our research focuses on the attribution of intention of the proposer with a minimum offer in a 2-round counter-offer ultimatum game. Specifically, we hypothesize that this attribution can be conveyed by the conversational context created by relevant linguistic information [8] about the proposer. Several studies on the ultimatum game have investigated the mechanisms underlying the reaction of proposers and respondents based on the submission of descriptive and psychological information about the proposer before the start of the game [9] and on the induction of positive or negative emotions before the start of the negotiation [10, 11]. These results showed that participants can be impacted by their past experiences. Thus, each acceptance or refusal of an offer must be interpreted within the whole system. If we consider interaction as important in the experience of negotiations, then it is essential to consider it as a system similar to communication where all the parts and elements of this system are interacting with each other [12]. Our second question is whether we can obtain the same intentional attributions when the conversational context is limited to a chatbot-like textual exchange. Is the intentional attribution conveyed by a relevant conversational context identified in the same way when the participant thinks they are having a discussion with an artificial agent through a textual exchange? We hypothesize that the presence of an intention conveyed by an artificial agent via a text-restricted relevant conversational context influences decision-making to decline or accept an offer in a manner similar to the more informative conversational context between two face-to-face people. An important advantage of this type of interaction is that it allows one to focus solely on the utterance and to completely isolate nonverbal behaviors. Indeed, it has been shown that individuals in Turing Test type experiments produce inferences and expectations about textual conversations. For example, the idea that conversational partners try to cooperate during a conversation by expecting the participants to respect Grice's 4 maxims [13]; 1) the maxim of quality, focusing on the truthfulness and certainty of a given information, 2) the maxim of quantity, focusing on the amount of information given (neither too much nor too little), 3) the maxim of relation, which suggests that participants in a conversation expect their interlocutor to be relevant, and 4) the maxim of manner, focusing on how information is given (briefly, clearly, in an orderly and in an unambiguous way) [14–17]. A recent study [18], again in a Turing test situation, shows that knowledge of the context and topic of a conversation can produce a significant decrease in the cognitive cost required to read written messages in textisms by providing additional cues to help infer the meaning of these messages. Participants acted as judges in a Turing test between a normal conversation (written in the traditional writing style) and a conversation in which the experimenter conversed with textisms, in a random order. The results indicate that participants responded more quickly to messages written in textisms when they were used in the second conversation.

Thus, prior knowledge of the conversation appears to help interpret written messages by decreasing the cognitive cost required to infer their meaning.

Here, we will give our participants the task to play the two-round ultimatum game with three players whose profiles and intentions can be inferred by the participants before the game begins through explicit and implicit cues. The participants will always start the first round by making a first offer and in the second turn of the game the three different player profiles will propose the minimum offer of one unit. In contrast to the classical experiments where the minimum bid is perceived as an aggressive bid because it is not justified, the participants will play with players whose particular profiles may suggest a minimum bid.

(i) The "stochastic" player whose offer of one unit will appear to the responding participant as the result of chance [3] and thus can be justified as independent of the player's own will and intentions,
(ii) The "homoeconomicus, rational" player, whose offer of a unit can be understood by the responding participant as the consequence of a rational decision to maximize his profit. This decision, made explicit to the player, can therefore be analyzed as non-aggressive since it is supported by the theory of economic decision-making and by the theory of the "rational" player.
(iii) The explicitly "selfish" player whose offer of a unit can be inferred by the answering participant at the beginning of the game. Here, the decision comes from the player's own personality and should be perceived as aggressive and as a deliberate violation of the fairness norm.

2 Experiment

2.1 Participants

92 participants (58 males and 34 females) participated in our experiment. The age of our participants ranged from 18 to 39 years (24.2-year-old on average, SD = 2.64). Participants were recruited via acquaintances. All subjects were native French speakers who gave their informed consent. We conducted 7 pre-tests in order to validate our experimental method. Participants were randomly placed in one of the two conditions of the experiment:

– The chatbot condition was composed of 40 men and 22 women. In this condition, participants were confronted to an ultimatum game via a chatbot interface.
– The face-to-face condition was composed of 18 men and 12 women. Participants were confronted to a face-to-face ultimatum game.

2.2 Materials

In our experiment, participants were confronted to three player profiles corresponding to the different intentions we wished to convey. In this revisited ultimatum game, we asked participants to make an offer to the player and subsequently respond to the player's offer.

We chose to put participants as the first proposer in this experiment in order to avoid participants being subjected to both the player's intention and the negative emotion of the player's unfair offer at the same time [19]. The player led the entire dialogue to its conclusion. It introduced itself and gave the participants clues allowing them to infer its intention through a relevant conversational context which defines how it would act (rational player/stochastic player/selfish player). Each profile had a different acceptance rate depending on the participant's offer. In a second step, it was the participants' turn to respond to the player's offer. All offers were similar (1 unit offer). Before issuing their offer, the player justified their intention again. When the participants had finished talking to the three experimental players, they were asked to answer a questionnaire to evaluate their strategic adaptation during the different games.

2.3 Procedure

Our experimental design is a semi-complete design that includes the nature of the interaction (chatbot or face-to-face) as a nested factor and the intention conveyed by the relevant conversational context of the players (stochastic, selfish and rational) as crossed factors. The experiment takes into account 2 independent variables. The first variable corresponds to the order in which the player is used (randomized except for the stochastic player which is always the first player) while the second variable represents the different conversational contexts of the different experimental players (stochastic, selfish and rational). We also have 3 dependent variables: The value of the participant's offer in the first turn (from 0 to 10 units), the participant's acceptance of the unfair offer in the second turn (acceptance or refusal), and the participants' assessment of strategic adaptation (Likert scale ranging from 1 to 5: 1. Strongly disagree/2. Disagree/3. No opinion/4. Somewhat agree/5. Totally agree). We were able to discuss and debrief the participants at the end of the experiment to collect their feedback. We also wanted to avoid raising suspicions about the regularity of our players' unfair offers, so we placed the stochastic player first in all conditions (justifying its unfair offer by a random process).

In the chatbot condition, the experiment was run using a chatbot interface we designed. All the scripts of the different experimental players were carefully prepared in advance but interpreted by a human player. Indeed, the interpretation by a human player allows avoiding important technical problems as well as a lack of adaptation to the participants' responses. At first, we pretended that we were conducting a study on artificial intelligence and that the objective was to measure how our players would behave. The experimenter also took the role of a moderator to give the instruction to the participant. The goal of our recruitment text and instruction was to avoid suspicion bias on the evaluation of their own behavior. We also made sure that participants understood that the experimental players were chatbots [20].

In the face-to-face condition the procedure was the same but different actors played each profile. We tried to limit and control the verbal and non-verbal behaviors so that they were coherent with the profile they were acting. The three profiles were divided into a non-intentional (stochastic) profile, and two intentional profiles: one was selfish and took decisions based on this personality and the other one was rational and took decisions based on rationality. When the participant transmitted having understood the instruction, the experiment began.

After a brief introduction about the randomness of its future offer, the stochastic player asked the participant to make an offer. Following the participant's offer, the player could either refuse or accept the offer (the acceptance threshold was an offer $\geq$ 3). In both cases, the player neutrally explained the consequences of the acceptance or refusal. It was then the player's turn to make a random offer (which was generated on the computer in the face-to-face condition) which was always 1. After the participant's answer, the stochastic player explained again in a neutral way the consequences of the negotiation.

The next profiles were seen in a random order. Both began by introducing themselves and in doing so gave clues of their intentions (depending on the profile). Each profile had a different acceptance threshold that was related to their personality. After the participant's offer the player gave its opinion according to its personality. Before the player made their offer, they justified it with a relevant conversational context [8] and gave their opinion of the participant's decision after it was made.

The selfish profile characterized himself as being the best at this game, and that he only cared about his own gains. He was meant to feel superior and condescending. If an offer better or equal to 5 was given by the participant, it was considered "suitable" and disappointing otherwise.

The rational profile introduced himself by saying he was an expert in economics and was purely rational. He accepted any offer (as refusing would mean he would gain nothing) and offered 1 unit, justifying himself by saying that it was the economically sound offer. If the participant refused, he said that he did not understand, that refusing was not rational.

Finally, we redirected the participants to an online questionnaire to inquire about their strategies, their preferences and their potential feedback.

3 Results

First, with respect to the value of the participants' offer in the first round, the analysis of variance reveals a significant main effect of conversational context on participant offer value ($F_{2,180} = 14.20, p < .001$). Participants are more generous overall in the face-to-face condition. We also observe a significant main effect of the player's profile on the value of the offer ($F_{1,90} = 13.68, p < .001$). We performed different post-hoc tests indicating that the stochastic player is more rewarded than the selfish and rational players ($F_{1,90} = 36.80, p < .001$) which are similarly rewarded (Fig. 1a).

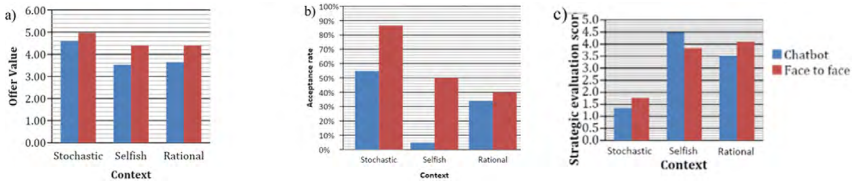


Fig. 1. a) Offer of the participants according to the conversational context of the player (in number of units); b) Acceptance of the unfair offer as a function of the player's conversational context; c) Strategic evaluation (5 points Likert scale) of participants based on conversational context. $N_{chatbot} = 62, N_{face\ to\ face} = 30$

Figure 1b shows the acceptance rates of the participants. We were able to find that the conversational context influences participants' acceptance rate of the unfair offer in the chatbot condition ($Q_{1,3} = 38.26, p < .001$) but also in the face-to-face condition ($Q_{1,3} = 12.78, p < .001$). We performed different post hoc tests in order to observe the differences between the contexts for the two conditions (chatbot and face to face). For the chatbot interface, we observe that the acceptance rate is significantly higher for the stochastic and rational players compared to the selfish player ($p < .001$). We also observe that the selfish player is rejected more than the rational player ($p < .001$). Concerning the face-to-face ultimatum game, we observe a significant difference between the stochastic player and the other players ($p < .01$) but no other difference could be found.

Following the experiment, we asked our participants to fill in a questionnaire concerning their strategic evaluation of the players (see Fig. 1c). We used a Likert scale from 1 to 5 (1. Strongly disagree/2. Disagree/3. No opinion/4. Somewhat agree/5. Totally agree). We performed a repeated measures ANOVA on the means of the questionnaire responses. We can observe a main effect of conversational context on strategic evaluation ($F_{2,180} = 170.90, p < .001$) but also an interaction effect between conversational context and nature of interaction ($F_{2,180} = 9.65, p < .001$). We performed several post-hoc tests that show that participants' strategic adaptation is more important regarding the selfish profile compared to the rational ($p < .01$) and stochastic ($p < .001$) profiles. Furthermore, we were interested in the interaction effect between the nature of the inter-action and the different player profiles. Our tests reveal that participants adapted significantly more to the stochastic and selfish profile in the chatbot condition than in the face-to-face interaction ($p < .001$). For the rational profile, we notice that participants felt they adapted more in the face-to-face interaction ($p < .01$).

4 Discussion

In both situations (with the chatbots or face-to-face), we observed that the attribution of an intention to the other player had an impact on the decision of the participants, similarly to what had been shown in [6]. Indeed, participants generally accepted the offer when given by a stochastic player. Yet we observe that participants in the chatbot condition did not accept the offers of the stochastic player as easily as in the face-to-face condition. Discussions with the participants during the debriefing indicated that they did not believe in the randomness of the stochastic player as much as those in the face-to-face condition thus it is possible that this would have had an influence on the acceptance rates.

Still, when there was an actual intention behind the offer of the player (either due to their personality in the case of the selfish player, or due to their strategy in the case of the rational player), acceptance rates were much lower. This is certainly the case because the participants refer to social expectations: if the offer is indeed random then it is out of the player's hands, and thus it is acceptable as refusing would not teach them to offer more on future turns. This is particularly obvious in the case of the selfish chatbot, for which the acceptance rate almost drops to 0. This player, by offering 1 unit, is blatantly avoiding cooperation with the participant, and thus the participant retaliates by refusing the offer. This behavior is likely made even more extreme by the chatbot interface, as people do not have to deal with the social consequences of refusing the offer, and thus can be more extreme in their intention to teach their partner not to play like this again.

The case of the rational player is a bit different. Indeed, we expected that participants, understanding the player's motivations, would offer a small number of units and on the next turn would accept the offer very easily, knowing that the rational player would have to accept it anyway, and yet participants do not seem to have changed their strategies despite the player giving them the solution of the problem, and thus cooperating. A possible interpretation was that participants might have assumed ulterior motives, or a personal desire hidden behind the rational explanation of the behavior which enters in direct conflict with the cooperative appearance of the player. Thus, even though participants likely understood what would have been rational, social rationality was still a stronger influence on their decision-making.

5 Conclusion

In this experiment we have shown that people have a tendency of sticking to habits of thinking and to only marginally adapt to the rationality of the players. We have also shown that participants understand the difference between an intentional offer and one that was not made intentionally and answer accordingly when receiving an unfair offer. Finally, we have also noticed that selfish behavior will result in a much stronger reaction from the participants when this personality trait is displayed by a chatbot than when it is a human in front of them.

These observations are a reminder that social reasoning is important to consider with chatbots, and that depending on the context participants will potentially display more extreme responses to unfair offers. Unfortunately, chatbots are to his day quite rudimentary in terms of pragmatic processing of the information [21, 22]. It is necessary to develop chatbots able to consider the internal state of the users when interacting with them [23].

Data Availability. All data and transcripts are found at https://www.doi.org/10.17605/OSF.IO/JVMS2.

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Human-Centered Design

The Face of Trust: Using Facial Action Units (AUs) as Indicators of Trust in Automation

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Abstract. Adaptive automation is pivotal for the calibration of trust between automation and its users. This paper presents an exploratory analysis into the use of facial expressions to trust in automation. This was done by analysing facial expressions of distrust and classifying into facial AUs composites, and comparing these to the 6 basic emotions. Results suggests the existence of two prototypical expressions of distrust that can be distinguished from the basic emotions based on AUs combinations. This shows promise into using facial AUs as a means for detecting distrust.

Keywords: Human factors · Human-systems integration · Systems engineering · Adaptive automation · Facial expressions

1 Introduction

In this age of burgeoning technological advancement and proliferation, there is a growing interest in research on acceptance and reliance of technology. A pivotal factor underlying acceptance and reliance is trust in automation [1]. Trust is the attitude that the recipient would assist the trustor toward goal-oriented outcomes, in a situation marked by imperfect information and unpredictability [2]. Trust and reliance often has a linear relationship, with higher trust correlating to greater use of automation, and lower trust correlating to less use of automation [2]. However, problems can arise due to a miscalibration of trust. Under-trust, the act of distrust when automation is trustworthy, can lead to disuse, while over-trust, the act of trusting in automation when it is unjustified, can lead to misuse and unpredictability [2, 3]. In situations of high stakes, the miscalibration of trust can have profound consequences. For example, researchers found that air traffic controllers (ATCOs) underutilized automation as they surmised that they were undependable. Proper calibration of trust can reduce the changes of misuse and disuse, and is pivotal in creating effective human robot teams [2, 4].

One way of ensuring proper calibration is the adoption of adaptive automation mechanisms which allow systems to modify levels of automation or operations based on

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 265–273, 2022.
https://doi.org/10.1007/978-3-030-85540-6_34

states of the operator [5]. For automation to be effectively adaptive, they need to be capable of real-time measurement of human mental states [6]. Recent research has seen some headways into establishing neurophysiological measures to correlate with trust in automation. These include brain imagining methods like fMRI, EEG, and fNIRS, and also other physiological methods like ECG, EDA, EMG, and eye tracking. However, due to the multifaceted nature of trust in automation, it remains to be tested if these measures are effective for different contexts and types of automation. These are highlighted in the review study by Ajenaghughrure et al. [7]. Additionally, many of these measures are intrusive in nature, which may possibly affect how users behave towards automated systems. Therefore, there remains much to be done in research on possible neurophysiological indicators of trust.

One possible indicator that remains largely unstudied is the use of facial expressions in the measurement of trust. Not only can humans recognize expressions irrespective of identity, they are also naturally impeccable at rapidly encoding different expressions [8]. Thus, Kaulard et al. suggested that for automated entities to be fully effective, they need to be able to perform ongoing analysis of expressions to adapt their behaviour appropriately, much like in human interactions [9]. This is reinforced by Pantie and Rothkrantz, whom posit that facial analysis capabilities would enable more seamless interactions with automation as expressions hold 55% of meaning within an interaction [10]. However, facial expression research has had a history of disproportionate focus on facial expressions of basic emotions (i.e., happy, disgust, sadness, surprise, fear, anger), which are the ones known to be universally shared and identifiable [11]. In spite that basic emotions only take up a small proportion of the mental states that humans experience, the rest of the more complex emotions have largely been left uninvestigated [12]. This trend is mirrored in research on automated facial expression analysis as well.

Facial expressions were posited to be crucial for a person's ability to read and portend another person's thoughts and feelings [13]. In that light, a pioneering study by Baron-Cohen et al. found agreement for expressions of 8 mental states, including distrust, across participants from 3 separate cultures (i.e. Britain, Spain, Japan) [12]. Recent advances have also seen more varied applications of facial analysis in the detection of other mental states such as fatigue and discomfort during driving [14, 15]. Studies of non-verbal cues pertaining to trust in automation have also emerged, supporting the possible use of facial expressions as an indicator of trust. Lee et al. found 4 cues, namely touching the face and hands, crossing arms, and leaning back, that together were predictive of lower trust [16]. Neubauer et al. showed that face expressivity of basic emotions in tandem with individual factors can be used to model and predict response patterns of users toward automation [17]. Thus, there is much potential in using facial expressions for trust measurement which remains untapped.

A crucial medium to the study of facial expressions are facial expression databases. However, databases of complex mental states are few [18], as they are time-consuming and cumbersome to create and document. Consequently, the McGill Face Database is one of the few databases that have been validated, and is the only known database that contains expressions related to distrust [19]. Databases also differ in the annotations provided, which are the types of meta-data tagged to the expressions. They can either provide basic face information such as facial features or action units, or higher-level

information like affect labels or dimensions [20]. Arguably, having annotations of facial action units would be most valuable for the use of a database. The facial action units (AUs) are a taxonomy of the smallest unit of isolated facial movement possible, identified in the Facial Action Coding System (FACS) [21]. As it is a standardized measure, it allows for comparisons and application irrespective of person. However only a handful of databases containing complex emotions provide such data, of which none have documented AUs of expressions of distrust [18].

Thus, having a database of validated distrust expressions with action unit meta-data will be beneficial for training automated systems to better detect distrust states in users and adapt their behaviours accordingly. This paper highlights a preliminary study intended to explore the existence of a prototypical characteristics of distrust expressions based on classification of AU combinations, and to discuss if these combinations are unique through comparisons with the 6 basic emotions.

2 Methodology

2.1 Procedure, Design, Apparatus

Pictures from the McGill Face Database were used in this study as the database contains validated expressions that are related to distrust [19]. All mental states were categorized based on the "Revised Reading the Mind in the Eyes Test" (RMET) [22], which is a comprehensive taxonomy of over 400 mental states. From their study, they found that individuals were able discern expressions of distrust through facial expressions. AUs for each of the distrust expressions were determined visually using basic encoding based on the facial AUs defined in the "FACS Investigators Guide" [21]. This is shown in Table 1.

Table 1. Facial action units and their descriptions.

AU number	Description
1	Inner brow raiser
2	Outer brow raiser
4	Brow lowerer
5	Upper lid raiser
6	Cheek raiser
7	Lid tightener
9	Nose wrinkler
10	Upper lip raiser
11	Nasolabial deepener
12	Lip corner puller

(*continued*)

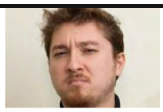
Table 1. (*continued*)

AU number	Description
13	Cheek puffer
14	Dimpler
15	Lip corner depressor
16	Lower lip depressor
17	Chin raiser
18	Lip puckerer
20	Lip stretcher
22	Lip funneler
23	Lip tightener
24	Lip pressor
25	Lips part
26	Jaw drop
27	Mouth stretch
28	Lip suck
41	Lip droop
42	Slit
43	Eyes closed
44	Squint
45	Blink
46	Wink

2.2 Analysis and Results

AUs Combinations for Distrust. Using the expressions that were characteristic of distrust, a systematic observation was carried out to find AUs that are prototypical of distrust. From the breakdown it can be observed that faces of distrust can be generally categorized into an activation of two different sets of AUs, albeit with certain variations. These two groups will be referred to as group A and B respectively. Analysed combinations of observed AUs are differentiated by group and reported in Table 2. In Group A it was observed that all except one included AU4. Additionally, all of them have either AU7, or AU44, which are both actions of narrowing of the eyes, with AU44 akin to a more intense version of AU7. AUs of their lower faces showed no consistent pattern across the group, but 3 subgroups were identified. Namely, two had AU10, two had AU25 and AU26, and one of them had AU18. Group B was characterized by the AU1 and AU2 pair, which occurs in three out of four faces. Similarly, AU5 and AU10 occurred together in three of the four faces. These four AUs mentioned here overlapped in two of the expressions in group B. Group B was not defined by any AUs of the lower face. Gleaning from

Table 2. AUs combinations for distrust expressions.

Group: Label	Expression	AUs expressed											
		1	2	4	5	7	10	12	18	20	25	26	44
A: Distrustful (Male)				X			X						X
A: Suspicious (Male)				X			X						X
A: Doubtful (Female)				X		X							
A: Distrustful (Female)				X		X					X	X	
A: Sceptical (Female)				X		X				X	X	X	
A: Suspicious (Female)									X				X
B: Doubtful (Male)		X	X		X		X						
B: Sceptical (Male)		X	X		X		X						
B: Dubious (Female)		X	X					X					
B: Dubious (Male)					X		X						

the observations, it may seem that distrust is expressed largely with movement of the eyebrows and eyes.

Comparisons with Basic Emotions. A comparison was carried out between AUs combinations for distrust and the basic emotions. Since some emotions have numerous variations (e.g., anger, fear), the analysis focused on sieving out the characteristic groups of AUs that occurred most frequently across combinations, and then compared these to the defining groups analysed above. AUs combinations of basic emotions from the "FACS Investigators Guide" [21] are shown in Table 3. From a comparison, it is clear that there are no significant overlaps between AUs combinations with distrust and disgust, happy, and sadness. Nevertheless, significant overlaps were observed between group A and anger, and between group B with fear and surprise. This is unsurprising as distrust, according to the definition provided, would arise due to perceptions of failure of the trustee to meet goal-oriented expectations of the trustor. Anger, fear, and surprise are all similar in the sense that they are reactive emotions that may often result when situations deviate from an individual's mental model. Nevertheless, distinctions could be found between distrust and the other emotions.

For anger, AU4 and AU5 always occurred together, whereas AU5 never occurs in group A even though AU4 was always present. Additionally, when AU25 and AU26 are present, they are always with AU23, which also is not shown in group A. It was observed that there was an overlap of AU1, AU2 and AU5 for fear, surprise, and distrust. In fear however, they are almost always present with AUs 25/26/27. These AUs seemed to be the defining AUs for fear, occurring in four of seven variations. Additionally, AU4 differentiated fear and distrust as they almost always occur with AU1, AU2, and AU5, but is not present in group B faces of distrust. It can be seen that there is a similar overlap of AU1, AU2 and AU5 between surprise and trust. However, they only occur with AU10, which is not present in faces of surprise.

Table 3. The 6 basic emotions and their encoding rule combinations. An annotation of "A/B" means that either "A" or "B" could occur.

Emotion	Description
Anger	4 + 5 + 7 + 10 + 22 + 23 + 25/26
	4 + 5 + 7 + 10 + 23 + 25/26
	4 + 5 + 7 + 17 + 23/24
	4 + 5 + 7 + 23/24
	4 + 5/7
	17 + 24

(*continued*)

Table 3. (*continued*)

Emotion	Description
Disgust	9/10 + 17
	9/10 + 16 + 25/26
	9/10
Fear	1 + 2 + 4
	1 + 2 + 4 + 5 + 20 + 25/26/27
	1 + 2 + 4 + 5 + 25/26/27
	1 + 2 + 4 + 5
	1 + 2 + 5 + 25/26/27
	5 + 20 + 25/26/27
	5 + 20
	20
Happy	12
	6 + 12
Sadness	1 + 4
	1 + 4 + 11/15
	1 + 4 + 15 + 17
	6 + 15
	11 + 17
	1
Surprise	1 + 2 + 5 + 26/27
	1 + 2 + 5
	1 + 2 + 26/27
	5 + 26/27

3 Discussion, Limitations, and Future Work

This paper presents preliminary work towards establishing a method of detection of distrust using facial AUs. The findings show promise in using AUs to detect distrust. Despite being closely related to anger, surprise, and fear, there seems to be defining differences between the expressions. The classification of AUs resulted in the discovery of two prototypical faces which are distinguished by features of the eyebrows and the areas around the eyes. This hints at the possibility that the eyes and brows hold more weight in the expression of distrust, and the lower areas are likely to be supplementary. Practically, more weight could be placed on facial AUs belonging to the upper face area when training adaptive automation for classification of distrust. This also supports recent advances that mental states are expressed through idiosyncratic expressions, much like basic emotions [18].

This work is not without certain limitations. Firstly, pictures from the existing McGill Face database were used, which only contains expressions acted out by 2 actors in controlled settings, which may impede the generalizability of these expressions [18]. Moreover, since there were only 5 labels related to distrust in the initial database, this limited the number of portrayed expressions available to only 10. It may be the case that there may be other variations of distrust that were not portrayed, or that they were expressed incorrectly by the actors.

Nevertheless, to fully validated the usefulness of AUs in detection of distrust, more work needs to be done. Faces of distrust should be studied in naturalistic conditions and analysed to assess if the AUs presented in this paper can be detected. In addition, a database of distrust faces should be created to facilitate training of automated detection. This will allow for more comprehensive training of detection algorithms and more accurate classification outcomes. To this end, creation of "in the wild" databases, which consist of videos taken in uncurated circumstances, can serve as a validation for the AUs classifications of distrust found in this paper. Additionally, this paper has focused on only faces of distrust. Future work should also examine possible expressions of trust.

4 Conclusion

This paper presents a preliminary step towards the detection of distrust in automation using facial expressions. Two prototypical AUs combinations of distrust were found, pointing to the eyes and eyebrows as defining features. These were also distinguished from the 6 basic emotions. This shows promise for the use of facial AUs to detect distrust. Nevertheless, the use of facial expressions should not be used as an isolated mode of detection. Future work should examine how facial expressions can be employed together with other established neurophysiological measurements for more comprehensive and accurate real-time measurement of trust and distrust.

Acknowledgments. The research is supported by the Civil Aviation Authority of Singapore and Nanyang Technological University, Singapore under their collaboration in the Air Traffic Management Research Institute. Any opinions, findings and conclusions or recommendations expressed in this material are those of the author(s) and do not reflect the views of the Civil Aviation Authority of Singapore.

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The Effect or Non-effect of Virtual Versus Non-virtual Backgrounds in Digital Learning

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Abstract. Digital learning and virtual backgrounds have been there for years but started to gain evident popularity after the Covid-19 pandemic. Now video conferencing tools such as Zoom, Google Meet and Microsoft Teams have become the new normal in almost every individual's life. This study emphasizes how students experience the use of backgrounds in a digital learning context. In an online survey conducted among students enrolled in higher education institutions in Norway, we look at the effects of real (non-virtual) backgrounds versus virtual backgrounds. Findings show that virtual background is not strongly preferred by students in a learning context, few students change background in digital lectures and some attention is paid to the use of backgrounds by lectures and fellow students. To some extent, the use of backgrounds is perceived as distracting, and changing backgrounds is linked, among other things, to doing so for fun. Grounded in our findings, we conclude with some practical recommendations concerning the use of backgrounds in a digital learning context and call for further research.

Keywords: Information technology · Mediated communication · Virtual backgrounds · Virtual classrooms · Digital learning · Covid-19

1 Introduction

Many individuals are using virtual backgrounds on video calls. Needless to say, not all backgrounds will invoke the same level of perceived professionalism and might in some cases appear as disturbing and out of place. Facing the fact that lots of teaching within higher education institutions has moved from a classroom setting to online lectures [1], the use of backgrounds is also highly relevant in an educational context. The sudden change after the closure in March 2020 meant that both lectures and students had to adapt to the use of technology in a very short time. Traditional classrooms in physical surroundings were suddenly replaced by online digital lectures. As a result of Covid-19 and the sudden high level of digital teaching, much focus has also been given to advising teachers on the use of tools, among other things [2]. For many, it was a steep learning curve in terms of extensive use of technology in teaching. At the same time, digital learning was a transition for students, who had initially signed up for classroom

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 274–281, 2022.
https://doi.org/10.1007/978-3-030-85540-6_35

lectures. The fact that many people work from home and new locations, suddenly the surroundings around were an element that was visible. If the camera is turned on, you can choose to change the background so that the surrounding environment is defined according to your own preferences. In this study, we distinguish between virtual and non-virtual backgrounds. The difference is whether you show the natural surroundings (not virtual), like your home or office space, or choose to find another motive, like a picture of a beach or inside a famous library. To dig into this area, the present paper emphasizes how students enrolled in higher educational programs in Norway experience the use of backgrounds in a digital learning context. Furthermore, how they respond to virtual versus non-virtual backgrounds. We draw on data collected through an online survey questionnaire, and report on quantitative and qualitative data. The aim of this study is to contribute to a research area that previously has not been given that much attention, but over the past year, has become a part of everyday life, especially in relation to business meetings and distance learning.

2 Related Work

Teaching and learning in higher education have changed rapidly in recent years with the extensive use of information and communication technology (ICT) [3]. Online teaching and virtual backgrounds became even more popular after the lockdown and Covid-19 pandemic in the spring of 2020. Although the nature of online experience and the feeling of close and distance social presence between teachers and students have been investigated by several researchers, not much attention is given to the use of backgrounds. Turner et al. [4] points out that if students and professors share the same environment (in an in-person class), the background is shared so it becomes less distracting. When students and professors do not share the same environment, the window into different environments can be distracting, as well as the various environments themselves can distract students. Other distractions they point out is the distraction in the form of text messages and notifications that arrive on the same devices as the online teaching platform.

Henshall and Oeppen et al. [5, 6] states that if you do choose to use a virtual background, you can play with it and even spring for a chance to demonstrate your style and your qualifications. Teachers change the background to improve the relationship with students and to be more authoritative, while students strive to feel comfortable when seeing themselves on screen [7]. Sometimes virtual background just do not look good due to tech lag and issues, and sometimes they don't work well with your computer [8]. A natural background allows you to show your audience a bit of your personality and is more authentic and less pretentious [9]. While these can be distracting at times, allowing the use of virtual backgrounds not only enlivens the class, but it can also provide the opportunity to hide clutter and allows students to participate in class without exposing their personal space to others [10]. Sometimes your home simply is not quite conference call ready! That's the time to consider using a virtual background or green screen for personal privacy and professionalism [11].

3 Study

We performed a survey with students enrolled in higher education programs in Norway with the goal of capturing initial perceptions of virtual versus non-virtual backgrounds. To create a basis for discussion, we designed a survey and collected data by using the tool SurveyMonkey. The data collection process took place in January to February 2021. The questionnaire consisted of a total of 17 questions and the measurement scale varied from closed to open-ended questions (with free text fields), so that the respondents could offer qualitative comments and fruitful insights. Before the survey was launched, we had an extensive discussion within the research team, regarding the questions and the use of measurement scale. Topics covered in the survey were: use of camera, preferences linked to backgrounds, distractions and attention paid to backgrounds. We also performed a pilot test to ensure that the questionnaire was understandable to the target group. Only a few modifications were made after the pilot test. To collect data, we created a link to the survey in SurveyMonkey and distributed the link to the respondents. In the beginning of the survey (first page), the respondents were informed that it was voluntary to participate, what the survey was about, processing of data and contact persons.

The survey was closed with 288 respondents (female 64%, male 35%, and unknown 1%) aged 18–24 years = 69%; 25–34 years = 26%; 35–44 years = 4% and 45 years or older = 1%. The participants came from different academic programs including technology, marketing and innovation, and design and communication. Not every respondent answered all the questions asked, thus, there are not 288 answers to each question. The completion rate was 93% and the typical time spent completing the survey was four minutes (reported by the survey tool).

Regarding data analysis, we received both qualitative and quantitative data. This paper focuses mainly on the quantitative part; however, we will also provide some comments given by the respondents. We looked at the distribution of responses over the measurement scale, trends, and patterns in the material.

4 Analysis

The goal of our study is to look at preferences related to different types of backgrounds and emphasize virtual versus non-virtual (natural) backgrounds. Figure 1 shows the distribution of answers among the respondents (n = 279).

As shown in Fig. 1 most of the respondents prefer natural background over virtual background during digital lectures, both among fellow students and lecturers. The figure also shows that almost 50% do not have clear preferences for what they prefer. At the same time, we also see that there are none very large differences related to preferences for the use of backgrounds, and what students find most preferable, among fellow students versus lectures. Overall, the virtual background experience scored lower on every perceived trait than the natural background. Although, we speculate that variables like personal likeness to use the latest technology and ability to use the virtual background can affect the experience. Nevertheless, both natural and virtual backgrounds were found to have no significant effect on the learning experience. Our findings also show that many of the respondents think it becomes unprofessional, frivolous, distracting, and false if a

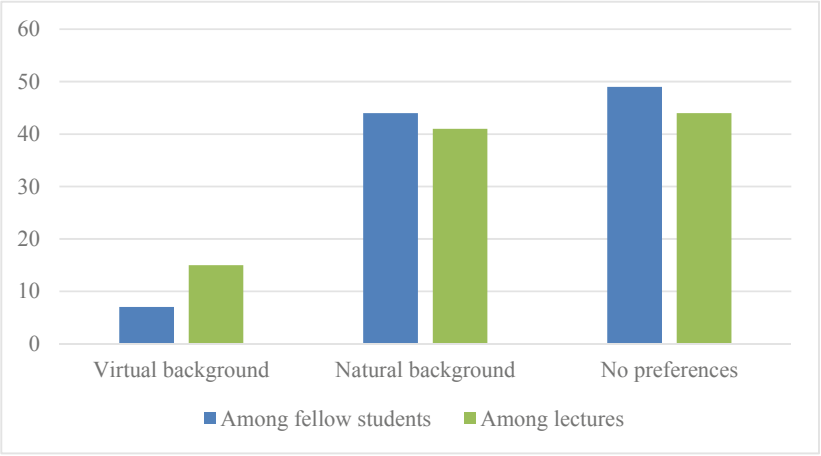


Fig. 1. Preferred type of background among the respondents. The numbers are reported in percentage (n = 279).

lecturer uses a virtual background. Some respondents give the impression that a natural background creates calm and harmony, while some students believe that it makes them relax when they see a natural setting in the lecturer. Some are also of the notion that the natural background makes the lecturer look more genuine.

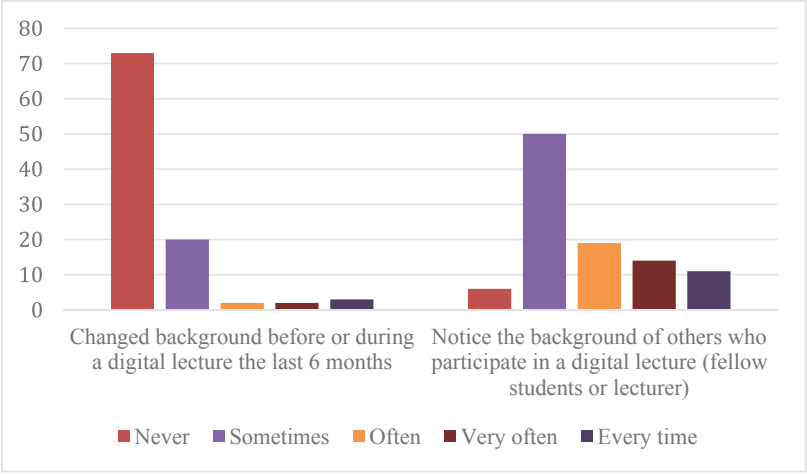


Fig. 2. Changes related to backgrounds. The numbers are reported in percentage (n = 279).

In Fig. 2 we see that almost 75% of the respondents have not changed their background during a lecture in the last six months. 20% have done it sometimes and almost none does it often or every time. Regarding the extent to which the respondents notice the background of those who participate in a digital lecture, we see half sometimes

notice the background, while almost 20% do so often. Between 11 and 14% do it very often or every time. The respondents were also asked in which situations they change background. The answers that dominate are: if there are other people in the background (22%), if it is messy in the background (22%), or that it is inappropriate to show up (19%). Several options could be selected. 52% answered that they never change background, no matter what. Based on the qualitative comments concerning this, we found that many of the respondents change background primarily for fun reasons. Explained by one of the respondents like this: "*Because it can be a fun twist in an otherwise somewhat academic everyday life*". While another one explained: "*Changing to fun backgrounds to entertain myself in class*".

If we look at how the use of background can create distractions among the students, almost 60% of the respondents have never been distracted by the lecturer's background; though, which means that using virtual background might not have any counter effect to the natural background. Moreover, 36% have sometimes been distracted, while 4% often experience being distracted. An overview is provided in Fig. 3.

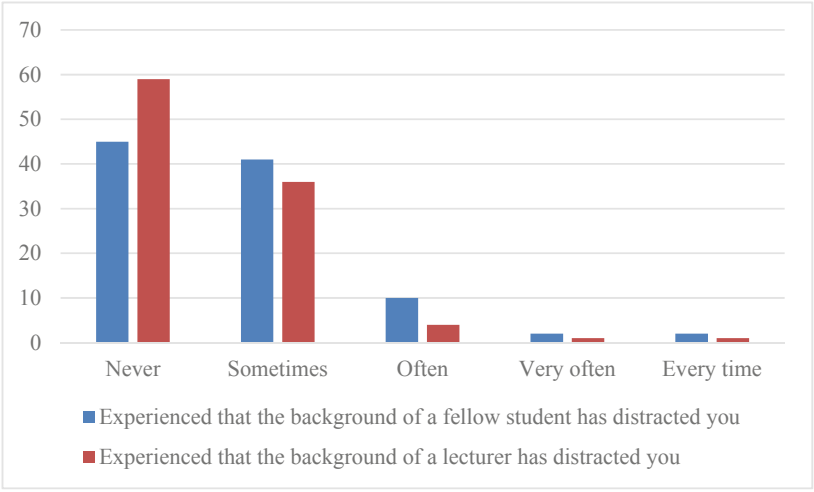


Fig. 3. Distractions related to backgrounds. The numbers are reported in percentage (n = 269).

We have also investigated which "screen view" the students prefer during a digital lecture. The majority (69%) prefer lecture slides (e.g., PowerPoint), in addition to a video of the lecturer. It is to a small extent that the respondents answer that it is preferable to have a video of fellow students (11%), and with regard to background, natural background is preferred over virtual background. Regarding the general use of backgrounds during digital lectures, the respondents also enriched us with some fruitful comments. Some examples are: "*I think virtual backgrounds are silly and very unprofessional*" and "*I think it can show a little more of the person's personality, which can be both fun and interesting. But it can also sometimes seem a bit unprofessional and distracting*". Another one: "*Backgrounds in teaching are not fun. Zoom has become 100% of our everyday life and it is as stupid and disturbing as if all students/teachers should line up with*

costumes at an ordinary lecture". And one more: "*For me, it does not matter what kind of background others use. I try to focus on the academic content*".

In contrast to this: "*Virtual backgrounds have often made it easier to focus, because one is not distracted by other possible elements in the background. One can be distracted by many things, even the interior of the home*". From these comments we can learn that there are different subjective opinions about the use of backgrounds, as well as different motives for meaning one or the other. Those who have offered qualitative comments have relatively clear opinions about what they prefer and how they experience different types of backgrounds.

5 Discussion

We have witnessed that teaching in higher education in recent years has greatly benefited from ICT [3] and the rise of online lectures [1], especially after the lockdown and Covid-19. This sudden change from physical classrooms to online digital lectures have made a steep learning curve in regards of extensive use of technology in teaching both for teachers and students [2]. A major change in digital learning is the inevitable change in location. No longer in a traditional office or classroom setting, location is now entirely dependent upon each participant's environment and choice. Your background makes a strong statement about you. You are quite literally projecting an image, whether professional or otherwise, to your students. In the academic settings, though the virtual background does not seem to have a huge impact over the learning experience, as shown in the findings as well. As we found that many students prefer that lectures use a natural background, our suggestion is to use the virtual background only for certain sessions where keeping the natural background is not possible due to distraction. Prior research found that most students prefer a neutral or natural background behind their backs [7], witnessing that they are aware of how they are seen by others.

Although distraction is not considered as a major concern, it is present, which means that it is important to consider what kind of background one chooses. Especially if you change to using a predefined image that does not represent the real world where you are during a digital meeting. Both virtual and non-virtual background can cause distraction [4], however, our findings reveal that more than half of the respondents have never experienced that lecturer's background has led to distraction. On the other side, about 40% have sometimes been distracted or often experience being distracted. This testifies that backgrounds in this setting can affect students and it is important to carefully choose a background. By choosing a non-virtual background, you can also choose to show some of your personality, while being more authentic [8]. Findings from this study also show that among students there are clear subjective preferences, and that some experience virtual backgrounds as unprofessional. Teachers change the background to improve the relationship with students and to be more authoritative, while students strive to feel comfortable when seeing themselves on screen [7]. To facilitate that students, experience good learning and are concentrated during a digital lecture, it is therefore important to choose a background that supports this. It is also considered unimportant that fellow students have on camera and by only having a video of the lecturer, one removes potential sources of distraction.

Our findings also show that, from a student point of view, backgrounds can be linked to fun and as an entertaining element and can also demonstrate your style [6]. Having the opportunity to change background during a meeting or digital lecture can also have some positive aspects. Among other things, through participation without exposing the surrounding environment [10]. In a classroom, one does not face the same challenges, and backgrounds thus provide an opportunity to decide for oneself what is visible to others. This also applies to lecturers, that overnight because of the lockdown, had to give lectures from home offices or other private locations. The use of a virtual background can also be considered to ensure privacy and professionalism if the environment is not representative for teaching students [11].

6 Conclusion

As virtual meetings continue to be the way we do business meetings, conferences, and lectures, we'll weigh the pros and cons of virtual backgrounds and the actual backgrounds. Though a non-significant percentage of students don't have any clearer preference, or they were unable to decide if the background really matters to them in terms of learning experience's effectiveness, one should consider that the choice of the background can cause distraction although it be can fun and show personality traits. A forthcoming contribution could provide recommendations on the effects that may linger to the relationship issues, as well as a best practice checklist that could be useful in the context of digital learning.

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Approach to Estimate the Skills of an Operator During Human-Robot Cooperation

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Abstract. This work presents a new approach to evaluate operators skills regarding their activities. This approach is based on an activity model composed of three primary activities. For each primary activities, an indicator has been proposed. The method has been applied in the case of a picking task. Results are compared with expert analysis and seem consistent. The approach shows there is no clear link between performance and skills.

Keywords: User-centered · Systems human-machine systems

1 Introduction

Today the presence of robots in our everyday private and professional lives is increasing. For many years now, robots have become key elements in the industry and even more so with Industry 4.0. They have made their entry into other fields such as agriculture with the Smart Farming and Agriculture 4.0. Since the 2000s and even more recently, the computing, control, and perception capabilities of robots have enabled them to evolve into complex environments alongside human operators. Nowadays, embedded intelligence in robots is also being used to make them cooperative. Thus, the latest developments enabled rich interactions between robots and humans. In this context and thanks to the benefits of the convergence of the fields of automatic control and human sciences, it is conceivable to configure and reconfigure in real-time the behavior and functionalities of a robot, allowing it to adapt to humans and their skills.

2 Background

To improve human-robot cooperation, the comprehension of the human by the robot is a key point. To do this, the robot must identify the state of its human partner. This state can be defined as the skill. In [1], the skill is defined as the capacity to combine a set of relevant resources to manage situations defined by key activity and requirements to produce satisfactory results. With the increasing presence of robots in our lives, considering human skill would improve integration and cooperation with the robot.

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 282–288, 2022.
https://doi.org/10.1007/978-3-030-85540-6_36

To identify skill, the use of operator models seems relevant. The most popular model is the Skills, Rules Knowledge model from Rasmussen [2]. Based on this model, [3] proposes the concept of know-how (KH) and know-how-to-cooperate (KHC) to model the operator. In [4] and [5], a hierarchical model is proposed. The model distinguishes the sensory-motor skill, the motion skill, the cognitive skill, the planning skill, and the social skill. Using these two models, different approaches allow evaluating skills.

In [6], skill evaluation using the model proposed in [4] is based on the realized task. In [7] using the same model, the skill is evaluated regarding the use of the system interface. In these two works, this approach is applied in the case of controlled tools. As far as human-robot cooperation is concerned, each agent performs different tasks with high robots' levels of autonomy. In [8], the model based on the KH and KHC agents is used to define types of cooperative partners. In other words, they proposed different skill levels which change the task repartition between human and robot. In [9], a similar approach is used and experts evaluate operators after task realization. Whatever the models, the activity is the key element to evaluate skills.

Improving human-robot cooperation in regard to the operators' skill is interesting and suggests an easier robot integration. But proposed models are complex and dependent on the situation (cooperation or not). So, is there possible to propose an independent model from the cooperation situation with a relevant estimation? Regarding this assessment, it is relevant to ask if there is a link between skill and performance?

Considering the previous element, a model to evaluate skills regarding the activity is proposed. This model was built in such a way as to evaluate the competence of the operator independently of the performance of the human-robot couple.

3 Skill Estimation Method

In robotic, the skill of the operator is used for many applications in human controlled robots. But with the development of robots with high levels of autonomy, the robot and the operator can realize different tasks in parallel. So, to assess the operators' skills in this condition, use the control tools is impossible. In this case, the use of the activity presents an interest and allows to evaluate operators' skills.

3.1 Activity and Skills

In [5], the proposed model focuses its interest on the task. The one from [3] is focused on the concept of knowing. In [10], tasks are attributed to know-how and know-how-to-cooperate. As reminder, the task is the set of prescribed goals and procedures, required performances and quality standards in a specific environment. The skill is the capacities to realize a specific task. Considering this, assessing skills regarding the activity of an operator is interesting and remains consistent with the proposed models. For this, an activity model has been proposed. This model is based on 3 primary activities:

- **Observation** which consists of taking information and analyzing them
- **Planning** which consists of scheduling actions, purposes and sub-purposes. It is established on observation

- **Execution** which consists of achievement of actions' sequences from planning

Whatever the chosen operator model, the tasks to be performed will be based on these three primary activities regarding a situation. The evaluation of these three activities can be used as a skill assessment under some conditions.

3.2 Skill Evaluation

All operators cannot be known or recognize by the robot. So, it is necessary to distinguish the learning and skills evaluation. It is hypothesized that learning is finished.

To evaluate skills, the activity of a skilled operator is compared with the activity of the tested operator. The further away the subject is from the skilled operator, the less skilled he is. Each primary activity is evaluated with one or more indicators. They need to be independent of the performance to distinguish these two concepts in results.

To consider skills evolution due to human factors, an indicator and its evolution are used to recognize the skill level. As the link between the indicator evolution and the consecutive activities of an operator is complex to model, a fuzzy inference system (FIS) is used. The result of FIS can be used to evaluate totally or partially one primary activity. After, the global skill is computed as a linear combination of them. Regarding the task, weight is applied to the different primary activities. To evaluate the global skill, the area defined by the three results for each primary activity is compared between the expert and an operator. This allows obtaining a percentage of skills.

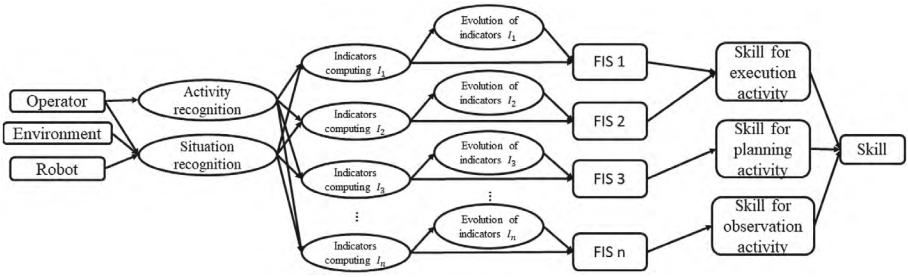


Fig. 1. Illustration of the approach to evaluate skills considering operator activity

As shown in Fig. 1, this approach is built on activity and situation recognition. The recognition accuracy and granularity will influence the assessment ability. The task can influence indicator definition but three indicators can be applied to any task.

The first indicator compares activity series (from primary activity: execution) between the operator and the expert. If the operator does an action transition that is not in the expert model, he loses points. This indicator can be expressed like this:

$$I_1 = \sum_{i=0}^{Nb_{action}} \delta_i \text{ with } \delta_i = \begin{cases} 1 \textit{ if transition is not in expert model} \\ 0 \textit{ if transition exist in the model} \end{cases} \quad (1)$$

If the score is near 0 the operator is close to the expert skills. This indicator allows estimating execution activity.

The second proposed indicator, inspired by hierarchical task networks, compares the subtask scheduling between the operator and the expert. Each subtask is weighted regarding expert scheduling. The proposed expression is as follow:

$$I_2 = \frac{\sum_{i=0}^{Nb_{subtask}} \left| L_{expert} - L_{operator} \right|}{2} \text{ with } L_x \text{ the series of realized subtasks} \quad (2)$$

This indicator allows estimating the planning activity of the operator. It is read in the same way as I_1.

The third indicator aims to objectify the operator's observation activity. It is proposed to check whether the operator's activity is consistent with the situation. The operator loses points if his actions are not relevant regarding the situation.

$$I_3 = \sum_{i=0}^{Nb_{situation}} \delta_i \text{ with } \delta_i = \begin{cases} 1 \textit{ if activity is not relevant to the situation} \\ 0 \textit{ if activity is relevant to the situation} \end{cases} \quad (3)$$

To apply this method, one FIS for each indicator needs to be designed. A knowledge base in the task context is needed too.

4 Application of the Method to Estimate Skills

This method has been applied on a simulated picking task. Data from a previous experiment [11] are exploited. Each subject needs to pick up five packages during 10 orders. 3 of these orders were realized with normal conditions and 7 were realized with disturbed conditions. For this work, only orders in normal conditions are considered. The indicators I_1, I_2 and I_3 have been computed. Two groups are created: one group of 17 subjects establishes the knowledge base and one group of 3 subjects tests the system.

Indicators application needs some precisions. The execution task corresponds to operator displacements in areas and picking up zero, one, two, or three packages. The expert chooses displacements to maximize the picking in areas. Subtasks are the picking up of packages. Experts organize the picking to avoid half-turns in the directions of the robot. Sometimes, the robot can encounter some problems. In this situation, the operator must help it and achieve suitable activities.

Each indicator is composed of three linguistic variables. Their membership functions are defined regarding the repartition of indicators value of the knowledge base group.

As shown in Fig. 2, the membership functions have been designed to present an equiprobability. With the output of each FIS, the global skill level is evaluated with the following weighting: 3 for the execution, 2 for planning and 1 for observation.

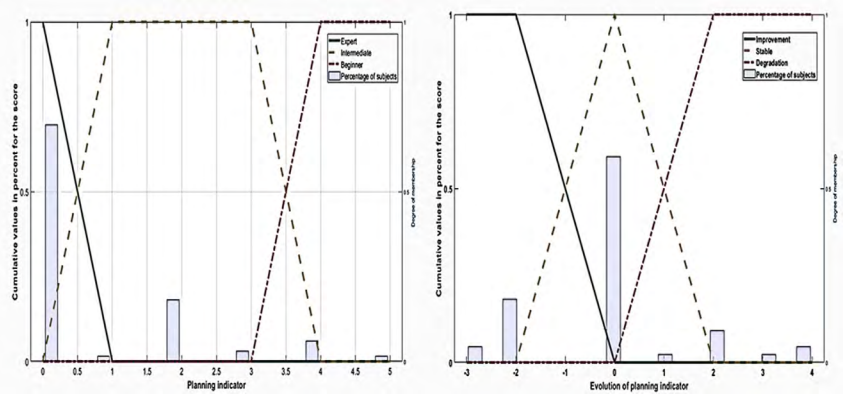


Fig. 2. Example of input membership functions

5 Discussion

The approach has been used on 3 subjects from the experiment group and compared with the analysis from an expert. Then, a comparison with the performance has been realized to identify the existence of a link between these two elements.

5.1 Application and Reliability of the Method

Three profiles were determined. A novice operator ("beginner") does not optimize his displacements, follows the packages list, and does not observe the robot. An intermediate operator ("intermediate") observes the robot, partially organizes his picking and improves his displacements. An expert operator optimizes his displacements, the picking and the robot's use. They are determined by experts with the video observation.

The three subjects studied were chosen because, according to the experts, they each belong to one of the three profiles at the first order. The table below (Table 1) groups together the skill values and profiles estimated by the experts. The values obtained are consistent with the evolution of the subjects' profile.

Table 1. Comparison between analysis and estimated skill

Subject number	Order 1		Order 6		Order 10	
	Estimated skill	Analysis	Estimated skill	Analysis	Estimated skill	Analysis
1	0.7141	Intermediate	0.9913	Expert	1	Expert
7	0.0649	Beginner	0.2182	Beginner	1	Expert
20	1	Expert	1	Expert	1	Expert

5.2 Comparison Between Performance and Skill

The comparison between performance and skill is realized in the experiment group. An observation of the point cloud seems to show some tendencies. To verify this, a test of correlation has been made. The test shows a negative moderate correlation between skill and performance (Pearson's correlation, correlation $= -0.575$, p-value < 0.0001 and $R^2 = 33.1\%$). But skilled subjects (skill score > 0.95) present disparate performance. Regarding these elements the separation between performance and skill is needed (Fig. 3).

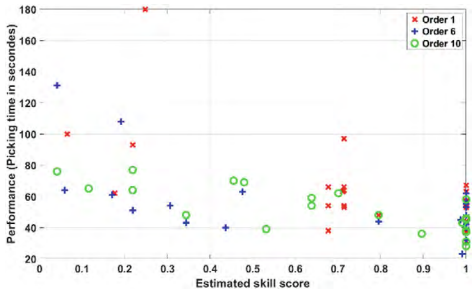


Fig. 3. Point Cloud of skill score and performance for order 1, 6 and 10

6 Conclusion

In this works, a new approach to estimate skills has been proposed, implemented, and tested. This approach is based on the operator activity and is independent from the cooperative situation. Its results on sample data seem relevant and allow identifying skill level. In addition, there is no clear link between skills and performance. So, a skilled operator is not obligatory a performing operator. These results would be confirmed on a new experiment with a larger group in real situations.

Future works will interest in the proposition for the learning evaluation and the use of this method to adapt some parameters of the human-robot cooperation with a view to contributing to the improvement of robot integration.

Acknowledgments. This research was financed by the French government IDEX-ISITE initiative 16-IDEX-0001 (CAP 20-25 with the support of the regional council Auvergne-Rhône-Alpes and the support with the European Union via the program FEDER.

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Adopting User-Centered Design to Identify Assessment Metrics for Adaptive Video Games for Education

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Abstract. Video games for education still remain unpopular educational resources and tools for learning. One of the reasons is that teachers do not understand the efficiency of video games for learning. In this perspective, the game assessment reports such as scores, points, and statistics have to provide meaningful information not only to players but as well to teachers and lecturers who have to assess and evaluate the learning outcomes. Considering the user-centered design approach, the present research aims to investigate how to select appropriate assessment metrics to make the game analytics and feedback reports for the adaptive video games for education more relevant for teachers and learners. The game metrics, collected before, during, and after the game experiences have to ensure relevant data for all end user's groups – teachers/lecturers, students/learners, system designers, and others. This research will be adapted for the design of the APOGEE platform for adaptive serious video games.

Keywords: User-centered design · Educational games · Analytics · Software instruments · APOGEE

1 Introduction

Video games for education are still hardly recognized and used as educational resources and tools for learning. On one side, not many teachers and educators are familiar with possible scenarios for using video games in their teaching strategies [1, 2]. On the other side, the player feedback and game assessment metrics, reported after playing educational video games, do not demonstrate clearly what are the students' achievements in terms of learning outcomes. This way, despite the accumulating literature for the benefits of educational video games, teachers and lecturers still hesitate to incorporate video games in their teaching [3]. Therefore, selecting appropriate game metrics and game feedback reports should clearly demonstrate how playing educational video games can contribute to achieving specific learning outcomes and competence level, making parallels with other educational activities and tools for learning.

At the same time, contemporary, adaptive and context-oriented video games support teachers and lecturers to design sophisticated learning games, using them as a tool for personalized teaching and better align to the learners' needs. The present research

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 289–297, 2022.
https://doi.org/10.1007/978-3-030-85540-6_37

will focus on how the APOGEE platform (http://www.apogee.online/) aims to support teachers in developing and evaluating educational 3D video maze games enriched with mini-games of various types representing appropriate didactic tasks [4]. Based on the user-centered approach and focusing on teachers and learners, the paper aims to investigate the relevant metrics, game analytics, and feedback reports of adaptive video games for education.

The structure of the paper is as follows. The next section makes a short overview of the main concepts of user-centered approaches and summarizes the main factors and metrics for measuring the user experience in serious games and video games for education. Then, to set a general framework, the APOGEE game-generating platform is described, identifying its specifics, system functionality, and capacity for adaptation and contextualization. Next, the focus is put on the process of collecting and analyzing data about the user and user gaming experiences, including appropriate pre-game self-report, log files with game session data, and post-game questionnaires. Based on empirical investigation, the main feedback metrics of the APOGEE video game for education are defined, considering both the relevant data for the maze game and the embedded mini-games. In the end, a more specific analysis is made on the main features of the post-game questionnaires and the design of the feedback reports for teachers and learners.

2 User-Centered Design for Evaluating User Experience in Educational Video Games

A short overview of the literature shows considerable research on models and methods for evaluating user experience in serious games and, more especially, in educational video games. Many authors propose various scales and metrics, considering specific aspects of the learning and gaming experience of the players. However, in the APOGEE platform, the main designers of the adaptive video games for education are teachers and lecturers. Furthermore, many of these teachers and students, designing and using games for learning are not supposed to be gamers. Therefore, teachers (in the role of game designers) need to understand: (1) whether one game is good enough to be used as a learning tool; (2) what are the students' preferences as learners and gamers, and (3) how effective for the learning is the designed video game. Furthermore, the games reports have to provide appropriate data and analysis for the teachers to adopt more personalized and student-oriented teaching strategies.

2.1 User-Centered Design and User Experience in Video Games for Learning

The main focus of the user-centered design (UCD) is, as part of the human-centered design (HCD), to estimate the needs of the end-users. Human-centered design is distinct from the traditional design practices because it prioritizes the people for whom the product, system, or service is intended, rather than the designer's personal creative process or the material and technological substrates of the artefact [5]. In the HCD perspective, the learner is put in the center of the education system, while the teacher is the provider of an appropriate learning experience. UCD is thus a multistage problem-solving process (not restricted to interfaces or technologies) [6] in which the needs,

wants, and limitations of the end-users of the product, service, or process are given extensive attention at each stage of the design process [7]. Furthermore, UCD highlights the role of testing and collecting data about user behaviour with real-world tests with actual users, using both qualitative and quantitative methods.

User experience (UX) is among the key concepts of the UCD and is a branch of Human-Computer Interaction research. Summarizing the literature [1] concludes that UX consists of all (qualitative) experience a user is making while interacting with a product; it includes affections, emotions, beliefs, and expectations that occur before, during, and after use of the product; it is directly and closely related to attaining the user goals. Further, [8] states that UX incorporates factors like effectiveness and efficiency, along with criteria like attractiveness, aesthetics, or joy-of-use, and UX focuses on the interaction between the users and the products or systems, and this interaction is depending on the surrounding elements.

Based on multiple studies, the UX in educational video games can cover the following factors:

- Gaming experience, learning experience, adaptivity, usability [9, 10];
- The quality of the product (game system experience), the quality of human-product interaction (individual player experience), and the quality of this interaction in a social, spatial, temporal, or another context [8];
- Reliability, validity, sensitivity, robustness, non-intrusiveness, and convenience [11];
- Physical elements (technology, demographic, architecture), social elements (political, cultural, economics), time elements (use the game for a certain time period), involvement (appeal, engagement, adaptation, retention); emotional and cognitive elements (inner emotional level); game content (goals of the game and learnability aspects [12]); fun and flow factors [1, 8];
- Technology (Usability, Quality of the system), Player (Understandability, Motivation, Engagement, User experience), Community (Social Factors) [13];
- Gaming experience (Fictional/Sensory Immersion/Affective Valence); Challenge (Challenge Absorption, Ownership); Playability (Variety, Clear Goals, Navigation, Help/Training); Usability (Control, Customisability, Consistency, Camera (Views) Game Interface) [14];
- Learnability; Efficiency; Memorability; Errors; Satisfaction [15].

2.2 Selecting the UX Concepts for APOGEE Game Experience

Based on the review in the section above, we decided to summarize the main factors for UX in games in three general facets: playability, learnability, and usability.

Playability. Playability consists of a group of factors such as Gaming experience, Challenge (the player's perceptions of difficulty of the game), Immersion, Game flow, Affect (confidence, self-efficacy, and attitudes), and motivation to engage [12]. Fidelity in a serious game can be associated with the level of realism that the environment provides to the user. Presentation of a game's graphics and audio affects player immersion and engagement.

Learnability. The learning experience is often associated with educational game effectiveness, the setting of clear goals, available feedback to provide a learning opportunity. The game content should be aligned to the curriculum within which it is embedded and educational goals. Content appropriateness and integration refer to game activity, promoting reflection on the knowledge and skills that the game provides to players, as well as encouraging the integration of knowledge from different areas to support player decision making, and develop new knowledge from the game. Media matching within serious games is used to identify the most appropriate media form to use, such as animation, sound, picture, or text within a game.

Usability. The UX characteristics of usability cover factors such as ease of use of the interface, user control within the gaming environment, the avoidance of errors, and satisfaction with the game's interactive features [11]. Usability explains how the user can achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use. The three components include (1) *effectiveness*: the accuracy and completeness with which players achieve specified goals - measured in completion rates and errors; (2) *efficiency*: the accuracy and completeness of goals achieved concerning player effort and resources such as time on task and number of trials; (3) *satisfaction*: the positive attitudes and experience from the use of the system.

In addition to factors of UX, that will be evaluated in the framework of the APOGEE game development, the following three questions (Table 1) will be considered in the game assessment: what should be assessed (what variables do we want to measure), why should be assessed (what is the purpose of collecting this information), how it will be assessed (the process of assessment).

Table 1. Factors for Evaluating APOGEE Video Games for Education

Teacher's view	Student	Player
What is assessed?	Learning experience	Playing experience
Why is assessed?	Learning efficiency, effectiveness, motivation and satisfaction	Gaming efficiency, effectiveness, motivation, and satisfaction
How is assessed?	Pre- and post-game questionnaires, In-game analytics	Pre- and post-game questionnaires, In-game analytics

3 APOGEE Software Platform for Educational Video Games

To set the general framework of the present study, we base the current research on the APOGEE software platform for the generation of personalized educational and adaptive video games. The platform is described in previous publications [16, 17], identifying its specifics, system functionality, and capacity for adaptation and contextualization. One of the main features of the APOGEE game platform is that it will enable non-professional

IT experts such as teachers and lecturers to design and make their own educational video games. The game engine provides a pre-defined maze, but the game designers can modify and personalize the number of the maze halls and their elements, as well as the educational mini-games, located in each hall. Based on the APOGEE game adaptation process, the game flow and the difficulty of the mini-games can automatically adjust, based on the data from the user profiles and user in-game experience. An extensive learning analytics engine allows teachers to get more information about students' learning and playing style and how this can contribute to learning adaptation inside and outside the game.

Figure 1 presents an overview of the APOGEE process of game creation and user data collection (top), game play and UX evaluation (middle), and game analytics and learning evaluation (bottom), which is developed based on [16]. The process is described step by step as each step provides a certain functionality and opportunity for the users of the APOGEE platform. After Game Design Evaluation, the process may optionally cycle on game design modification and further validation, generation, build and deploy of a new version of the same game.

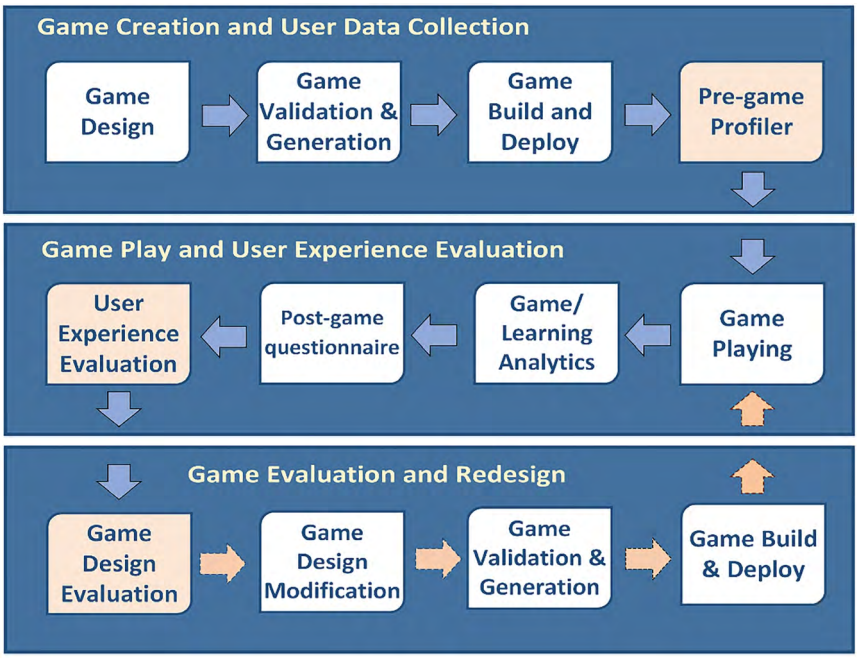


Fig. 1. The APOGEE game development and evaluation life cycle

Adopting a User-Centered design approach, the APOGEE game designers - teachers and lecturers, need to get better information about (1) the learning and playing experience of the students; (2) the general evaluation of their video game; (3) the learning outcomes with the game platform (that can be later compared to other learning activities and materials). In this perspective, teachers need to get relevant data and analysis reports,

allowing them to fine-tune the mini-games and evaluate the efficiency and effectiveness of students' experiences in the maze game.

To cover all phases of the UCD, the APOGEE platform proposes a three-level process of collecting and analyzing data about the user and user gaming experiences. The data collection mechanisms include appropriate pre-game self-report, log-file data, and post-game questionnaires. In plus, teachers can organize students' observations, focus groups, and interviews, to get more insights and inspiration about how to design entertaining and efficient educational video games. The pre-tests are independent of the game experiences and thus learners can fill them only once when registering into the system. The log files collect data about the in-game experience. The post-game questionnaire can on one side evaluate the game learnability, playability, and usability, and on the other side, a specialized questionnaire is provided for assessing the usability and effectiveness of every mini-game.

The whole process of collecting data APOGEE platform includes 4 questionnaires as follows: Pre-game: a questionnaire for the personal characteristics of the player having 10 questions about age, gender, fun game and learning game experience, learning and playing goals, and initial knowledge in the learning domain; the VARK questionnaire on the player' learning style with 16 questions and the ADOPTA questionnaire on the player' playing style with 16 questions [18]; and a post-game experience questionnaire on learnability, playability, and usability of the game with 16 questions. All these questionnaires can further provide data to compose more relevant metrics and feedback reports based on descriptive characteristics (mean, deviation, and standard error), correlations, T-tests, effect size, ANOVA, and others between personal student characteristics, students' learning, and playing styles, and the game outcomes (time, points, effectiveness and efficiency – for both the maze and its mini-games), learnability, playability, and game usability. The game outcomes can summarize the collected points, playing time, effectiveness, and efficiency for the maze game and any puzzle game. But more importantly, game designers – teachers, and lecturers will be able to better understand the impact and the feedback analysis of educational video games.

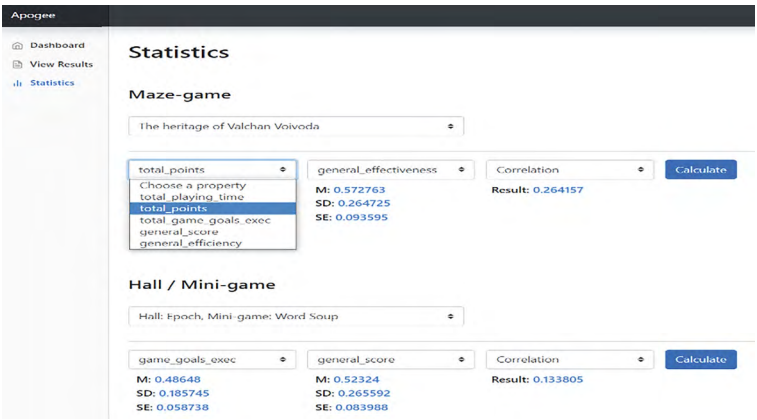


Fig. 2. View of the analytics page

Figure 2 provides a screenshot of the APOGEE online analytic tool for presenting individual and per-game learning/playing metrics and analytics (correlations, T-tests, effect size, ANOVA, etc.). Based on the statistics about outcomes of the game and self-reports, the system helps teachers to infer (1) what are the students' preferences as learners and gamers (2) whether the game is good enough to be used as a learning tool; and (3) how effective/efficient for the learning is the designed video game.

4 Discussion

Contemporary, adaptive, and context-oriented video games can facilitate teachers and lecturers not only to design sophisticated learning games but also to adopt personalized teaching strategies, better adapting to the learners' needs. Educational video game analytics should collect data for generating meaningful feedback reports both providing relevant analysis for learners and teachers and considering the gaming and the learning experience. The useful game reports can convert the relevant data into a mix of indicators, covering learners' knowledge and game experiences before, during, and after playing the game. The process can combine data about the learner's profile (and his learning and gaming styles), along with other pre-test surveys, log system data, and post-test surveys for examining user experience and user interactions with the system. Furthermore, the game metrics have to be designed in a way to provide relevant data for both end user's groups – game designers (teachers), and game users (students/learners).

Unfortunately, as discovered in [19] there is no specific recipe for fun. The usability and effectiveness of productivity tools can be measured in terms of production, throughput, efficacy, and efficiency. But other aspects such as learning impact, engagement, or fun are much more subjective and difficult to measure. This subjectivity and elusiveness impact formal usability testing protocols when applied to games. In summary, evaluating the usability of games presents unique challenges and requires metrics and methodologies that aim to contemplate their variability and subjectivity of interacting with games, as well as their uniqueness as exploratory experiences [19].

5 Conclusion

The design of serious games for education is a complex task in which designers need to create products that engage the audience and provide an engaging learning experience, weaving gameplay features with educational materials. Allowing teachers to adopt UCD and to explore how they can evaluate and fine-tune educational video games can generate further interest in their use. Furthermore, in-game metrics should not only focus on the main typical usability testing methods, focusing mainly on measurements such as productivity, efficacy, and efficiency as well as low variability, number of errors, and pauses. This way teachers and lecturers will learn that games are good to contemplate reflection, exploration, variety and trial, and error activities.

Acknowledgments. The research leading to these results has received funding from the APOGEE project, funded by the Bulgarian National Science Fund, Grant Agreement No. DN12/7/2017, and from the National Scientific Program "Information and Communication Technologies in Science,

Education and Security" (ICT in SES) financed by the Ministry of Education and Science of Bulgaria.

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The Contribution of Online Platforms to Alternative Socialization Opportunities of Architecture Students

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Abstract. The aim of this study is to investigate the opinions of architecture students about the usage of online platforms as alternative socialization environments during the Covid-19 outbreak. Accordingly, a questionnaire was directed to students of architecture from different levels in the host university to see and compare their opinions and preferences about the contribution of online platforms to their socialization needs. Results indicate that digital platforms in online studio contribute to socialization between students, but still need to be improved.

Keywords: Socialization · Architectural design studio · Online platforms · Covid-19

1 Introduction

Architectural education is a complex and intertwined process consisting of learning, experiencing, and interaction. The core of this process is the design studio, which has the most intense course hours in the curriculum and where students spend the most time during their architectural education. Design studios have rituals, such as master demonstrations, design reviews, desk critiques, and juries, all attached to a core process of learning by doing [1]. These rituals not only provide a critical understanding of education where instructors and students interact but also make design studios a strong communication and socialization environment. Architectural design studios are active and living environments where students collaborate, discuss, and even spend their time outside of class hours. They have a different spirit and spatial character from the conventional education approach in which learning is considered an individual act. In this context, architecture, where studio culture, sharing, and interaction are essential, is a branch of education that also defines its social environment.

The Covid-19 pandemic, which has deeply affected all areas of life, also caused some compulsory changes in the architectural education system and thus in the studio culture. Within the framework of restriction decisions, many institutions rapidly switched to the distance education model to ensure the continuity of education and training. The

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 298–305, 2022.
https://doi.org/10.1007/978-3-030-85540-6_38

transition from face-to-face education to distance education in universities has led to the evaluation of educational activities and methods with a mandatory new perspective. Although this was difficult for all disciplines, it has become even more challenging for architecture, which has a unique understanding and culture of education. In this process, within the scope of the new education model, architectural design studios have been transformed into online studios where representation tools and learning environments are digitized. This situation also caused the reconsideration of socialization and communication opportunities created by the physicality of the design studio. In the online education process, the social environment provided by the physical studio has been replaced by digital platforms where visual and audio sharing is possible. It has caused students to change their socialization habits and turn to alternative methods to interact with each other and to continue their sharing in the digital environment. According to this, in the study, the ideas of architecture students about socialization opportunities in the online education process and the effects of digital tools on socialization are investigated.

The general structure of this paper is organized as follows: The next section focuses on the socialization in architecture education and the importance of architectural design studios as part of this process. In the third part, transition to online living with the pandemic and socialization through digital platforms are mentioned. The fourth section includes the survey design, statistical analyses, results, and outcomes. The paper ends with the conclusion part.

2 Socialization in Architecture Education

Communication is essential for architectural education and the design studio is the environment which provides the motivation for social interaction among students. As part of the architectural education, the studio culture is based on sharing that creates a social environment. So, studio is the common ground where students are socially and culturally nurtured, while it provides a space for academic activities [2–4]. According to Nicol and Pilling [5], the social culture approach of the school is also decisive for the students to acquire the attitudes, skills and values during undergraduate education. In particular, the design education is a process, which is enriched by discussions and interactions mostly in the design studio. Shoshi and Oxman [6] define the design studio as places where architecture students spend the most of their time and learn design methods.

In the architectural design studio students develop design ideas, present them verbally and visually, observe peers' work, listen to the discussions and also make friends. Schön [1] states that the students learn a new language in the architectural design studio that the education process is based on it. The communication in the studio, which is different from the traditional classroom, is based on mental activity and social interaction between the instructor, student and all other students in multiple ways [7].

Furthermore, the design process has a social aspect that the preparation of the architectural projects requires teamwork. Therefore, social skills are some of the essential components of becoming an architect. The social dimension, which requires strong communication, becomes active also during the situations that depends on understanding the expectations of potential users, having a design understanding related to the community,

or working in groups. In that sense, the studio is the place where communication starts and socialization skills developed where students learn to collaborate, work as a team, understand the others and learn from them.

Especially, the capability of students to socialize is important as a part of design process from the perspective of the role of the designer. It is a fact that the interaction with the user groups as part of the design method effects the degree of success and efficiency of spaces [8]. The lack of social skills may negatively affect the process. Moreover, concepts such as social architecture or community architecture gains ground in-Covid times due to the socio-economic fragility of the World. This has a reflection on the architectural education as well. The concepts such as social sustainability or inclusivity become basis for the subjects of the design studios.

Also, physical comfort conditions are important for every student to work comfortably in the studio and the spatial characteristics of the studio that encourages social interaction between users is much more important. The spatial organization for being aware of the other students' actions is the condition to maintain studio as a social space [9]. So, students express themselves and they are influenced by the thoughts of each other and instructors [10]. In brief, the conventional studio has always been a shared social space. However, in-Covid times, the physical studio is converted into a digital environment. Although the students joined the online studio through digital platforms, physical environments such as home or dormitory have become the spaces where they continue to study. Socialization is also carried to online platforms that are limited to the inclusivity of the physical studio. It seems that alternative online platforms should take part to compensate or support the social aspects of the studio.

3 Online Platforms as New Socializing Environments

Online platforms are part of the daily life as being digital spaces of work, shopping, business, entertainment and socialization. Though their frequency of usage has been continuously increasing since the beginning of 21st century, Covid-19 outbreak had accelerated its spread in a radical way due to the prevention measures for minimizing physical interaction. Today, platforms such as Zoom, Skype, and Webex are being used for official meetings, and social gatherings. The daily user rate of Zoom raised 378% from December 2019 to March 2020, as Microsoft announced 40 million daily active users for Skype in March, 70% [11]. Virtual communities are one of the essential subjects of Internet and the applications enable people to meet new people and become social groups that similar to geographic communities from many aspects [12]. Moreover, multiplayer online role-playing games (MMORPG) start to take part in the socialization of young people including interactive tools like live chat and graphic communications [13].

Degraffenreid [14] remarks the young generation of the new era, including 'Generation Y' and 'Generation Z', have a tendency to place strong value on connections, knowledge and freedom of expression. Especially, 'Generation Z' have grown up using technology with a wider social capacity, such as instant messaging, designing Facebook pages, or making videos and broadcast on You Tube. So, online education, and even social media as part of education are familiar to them [15]. In Covid-19 times, obviously, there is an accelerated increase about the time that the young people spent on

social media platforms. For instance, even in pre-Covid times, the students, have used to find the social networking sites more attractive than educational ones [15]. Due to the analytics of 2009, the time young people spend on instant messages, text messages, and social media has become approximately thirty-one hours per week [16]. Also, the social interaction aspect of virtual environment is emphasized very strongly and accordingly the ability for students to express themselves, and socialize through digital tools is given as another aspect [15, 17].

Inevitably, digitization has become a wider part of the education in Covid-19 times. Adaptation of the studio rapidly into the online process brought the highly use of digital tools for drawing, representation and communication between students, and instructors. Communication methods of the online architectural design studio occur in digital environments that allow students to get involved with their design problem under the guidance of the instructor. Therefore, online design studio is a necessity to bring together students and instructors for education, also it has another role for providing a socialization opportunity among students. Although the discussions support the social presence of the students during online sessions, the social networking sites should have been occurred among other digital platforms. Furthermore, online exhibitions of the student projects on Pinterest, and virtual exhibitions might have been the new ways of information exchange with a wider audience and social networking. On the other hand, the online platforms and social networking sites for friendship, or co-working must have become a requirement for students out of online studio hours. Yet, Schneiderman [18] has given emphasis on the role of social relations on the purpose of learning that the engagement with people is much more necessary than storing facts in the student's head. Especially, the influence of social media on education, or the relation between the social media tools and educational teaching has already became widespread research area. For instance, educational courseware, and designing research tools for social media applications are part of the social media research topics of The Lab for Social Computing (LSC) [15].

It is necessary for online and blended courses that students participate in discussions and socialize. The social aspect of the online classroom is the topic of education for a number of years. Hughes, et al. [19] was concerned with the social cohesion of the students in an online classroom. Rourke et al. [20] stated the ability of learners to engage socially for the social presence and Picciano [21] found a relationship between social presence and participation in the course. In recent years, social media software programs such as Facebook, MySpace, You Tube, Second Life, Wiki and blogging tools have entered to the classroom as part of the social aspect of learning [22, 23]. A social network analysis of an online class shows that the number of messages a student received is an indicator of prestige and the number of messages a student sent out is an indicator of centrality [24]. In that sense, the integration of online social networking for educational purposes is suggested to fill the gap between learning and social cohesion [15].

4 Survey on Students' Online Socialization Preferences

The change of students' behavior on socialization was investigated through a survey among architecture students. The structure and the results of the survey are explained in the next chapters.

4.1 Structure of the Survey

The survey was conducted among architecture students from various levels, with a 5-point Likert scale to convert the results into quantitative data. A total number of 212 students participated in the survey, 52 of them being first year, 56 second year, 59 third year, and 45 fourth year students. The general results of the survey are described in a previously published article by the authors [25]. This paper elaborates its certain sections concerning socialization preferences of the students.

These sections included questions about the online tools the students used as communication tools, the change in their sense of belonging during online studios, and the replacement of the physical discussions with alternative online tools for socialization. The results of the survey revealed that students were quite positive about socialization in the online environment.

4.2 Results and Outcomes

This paper focuses on 5 important questions about students' understanding of socialization during the online studio process (Fig. 1). First question is about whether the students think they learned alternative communication tools such as Zoom and Skype. The mean value for this question is 4.17/5, which means that the students highly agree with this statement. 3rd year students were the group which had the highest results from this question with a mean value of 4.36, as 4th year students had the lowest average with 3.98.

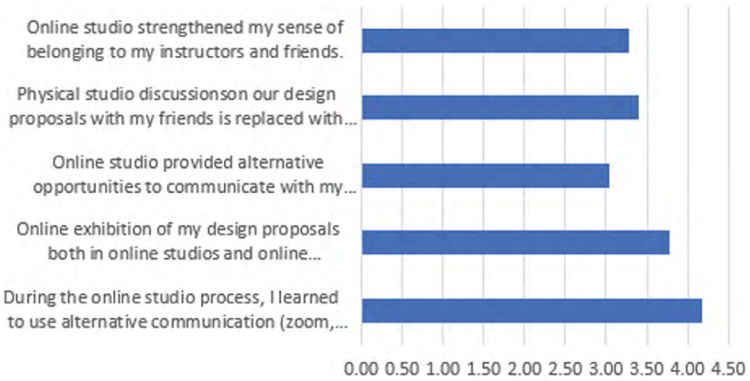


Fig. 1. Mean values for relevant survey questions (source: authors).

Second question asks students whether online exhibition platforms such as Pinterest contributed to their motivation as a medium to publicize their work. This question received a respond of 3.78/5 points. Apparently, students appreciated these alternative tools for exhibition as a contribution to their recognition as prospective architects. In this question, the highest mean value was received from first year students with 4.06/5, as the lowest results came from second year students with 3.61/5 points. These results

reflect the enthusiasm of first year students for architectural education even in forced online studio conditions.

Third question investigates the social aspects of online studio platform as a communication instrument. This question received the lowest mean value from the students with 3.05/5. Comparison between groups of different levels, the highest results came from first year students with 3.17, and the lowest results came from second and fourth year students with 2.96. These results show that although the students accept the online studio platform as a learning environment, they don't use the same medium informally for socialization.

Fourth question is interested in students understanding of other online social platforms being alternative environments for informal discussions about their design development and ideas. The mean value for this question was 3.41/5 which shows they chose to use social media frequently for the discussion of their design problems. The highest results for this question were received from first year students with an average of 3.62, as the fourth year students came up with the lowest results with 3.18. The results for this question show that first year students are more open for new and alternative communication methods and media, as the older students try to hang on to traditional methods of socialization (Fig. 2).

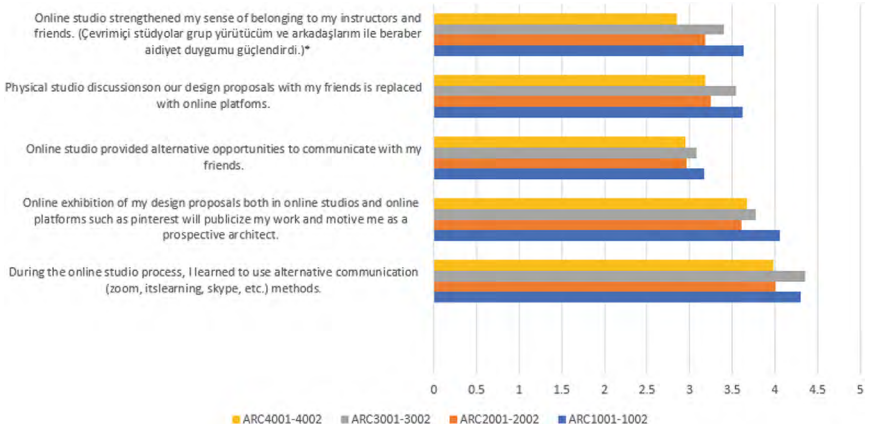


Fig. 2. Survey results based on student groups (source: authors).

Fifth question is a more emotional one that tries to understand students' sense of belonging to their friends and instructors. The mean value for this question was 3.28/5. First year students think that the online studio strengthened their sense of belonging to their friends and instructors more than the other student groups, as they have the highest mean value for this question with 3.63, as the fourth year students had the lowest one with only 2.84. Apparently, the first year students who are not familiar with the environment in the higher education institutions were content with the opportunities provided by online tools, as the older students were more demanding in terms of their social and personal need.

5 Conclusion

Education environments in the whole world are currently transforming under the effect of opportunities provided by online tools. The survey in the scope of this paper supports the idea that it is being embraced by the students as well. The results show that architecture students can adapt to online design studios, even in hard times such as the pandemic in 2020. Sudden changes in the education system were initialized by the students and educators to be implemented into the design studio utilizing proper tools and platforms for communication and collaboration.

On the other hand, the survey also indicates that students who have more experience in physical learning environments are harder to be convinced to online studio. Even though they are using social media and online platforms in their private lives, 4th year students' answers to the survey showed that they do not easily accept and initialize the methods and ways of the online design studio. First year students who have less experience in architectural education are eager to get involved in architectural education in any method possible so that they are more open for online tools for the design studio, including the tools for socialization.

Consequently, students of architecture who participated in the survey proved themselves ready and willing for the socialization opportunities provided by the online design studio. General situation in architectural education also points out to online platforms to be suitable tools for education, especially for the studio. However, online studio environment is still in the developing phase and it needs to be upgraded for better student and educator experience. Academic studies in this field would definitely be helpful for the improvement of online education platforms in the future.

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May I Show You the Route? Developing a Service Robot Application in a Library Using Design Science Research

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Abstract. The present study demonstrates the ongoing development of a service robot application in a campus library through the application of Design Science Research (DSR) combined with user-centered design (UCD). In particular, we involved librarians and co-created an application solution addressing two use cases: giving directions to a desired subject area/book and providing recommendations for an event/book. Additionally, we involved potential end users to evaluate the robot artifact through an onsite usability test (N = 14) already within the design cycle. This process resulted in a successful application of the robot artifact for the identified use cases and shows feasibility of combining DSR with UCD.

Keywords: Service robots · Design Science Research · User-Centered Design

1 Introduction

The usage of service robots that take over assistive tasks in various contexts will strongly increase in the near future. However, research on service robots is still a relatively new field and thus far mainly conceptual [1]. Since service robots closely collaborate with humans in shared work environments, it is important to integrate users in the design process of these robot applications. Design Science Research (DSR) is an approach applied in Computer Science and Information Systems research with the goal to either generate artifacts or theories, thereby providing applicable solutions with measurable improvements in an application context through the design of an IT artifact as well as novel inputs to knowledge [2]. The identification of a problem or use case for the application of an IT artefact is usually the starting point for DSR. However, the core of DSR is the design cycle with iterations of artifact design and artifact evaluation [2]. DSR projects do not solely result in novel IT artifacts, but also in the design and the deployment of the required processes necessary to successfully implement the artifact in the respective context [3].

Even though DSR is increasingly established in the area of Computer Science for the last 20 years [4], it has not yet been widely applied and tested with regards to robotic

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 306–313, 2022.
https://doi.org/10.1007/978-3-030-85540-6_39

systems (e.g. [5]), especially service robots and has not yet consistently involved end users in the design cycle (e.g. [6]). However, integrating users in the design process for technologies can increase user acceptance and thereby generate added value of the technological artifact [7]. The present work aims at illustrating an ongoing effort of combing DSR with user-centered design (UCD) to develop a service robot application that is accepted by users and generates added value for the library.

2 Awareness of the Problem

In our project, problem awareness was motivated by the potential usage of a service robot in the target library. To create awareness of the problem, we applied various approaches to learn about the challenges of the librarians with regards to their work processes as well as how they think a robot can support these work processes and address the identified challenges.

First, we identified two types of use cases that exist for the application of service robots in the library context through a literature review: maintenance/support-related tasks (e.g. [8, 9]) and learning-related tasks (e.g. [10, 11]). The introduction of service robots in libraries has advantages (e.g. supporting the librarian in their work processes) but also challenges for the librarians (lack of expertise in mastering the new technology) [10].

Second, we conducted a focus group (N = 3) with the goal to gain insights into the context of the target library and the librarian's opinions about potential support provided by the service robot. We employed a mutual shaping approach [12], which describes the dynamic interaction between technology and humans and stresses the mutual influences on each other throughout the phases of technology design, usage and evaluation. This approach allowed mutually shaping the solution design for the use of a robot in the library. We slightly adapted the approach to conform to the online format. Finally, to round off the focus group we asked the participants what challenges and opportunities they saw with regards to the use of robots. The outcomes of the focus group were a dozen of use cases (e.g. FAQ) and insights on the attitudes (e.g. mostly positive attitude and curiosity) and concerns (e.g. additional effort to maintain the robot) that needed to be addressed.

Lastly, together with a dozen library staff, we participated in an external workshop to discuss the use of service robots. Among others, the workshop resulted in a set of additional use cases and their prioritization based on the preferences of the library staff.

3 Solution Suggestion

The insights gained from the first phase of DSR resulted in 14 use cases for the robot application in the library. These use cases were then ranked by the librarians based on: urgency, usefulness, and fun factor with the former two reflecting the library's perspective and the fun factor depicting the visitor's motivation to use the robot. The library team allocated a maximum of five points for each criterion for all the use cases (five = "very high"; one = "very low"). Each use case could reach a maximum rating of 15 points. The use cases were then sorted based on their overall rating. To increase the impact and

scope of the project we then excluded those use cases that were already implemented at another campus library, because they can be adopted with minimal adjustment, and those use cases that were under current development by our collaboration partner. Finally, out of the initial set of use cases, six use cases remained for final selection. With 14 points each, use cases regarding the advertisement of upcoming events and the recommendation of newly arriving products (e.g. books, magazines) scored best, followed by a use case on providing directions to specific areas in the library and the location of books (12 points). We merged the first two use cases into one because of their similarity, namely, to recommend the visitor something new. After aligning with the library team, we decided to implement a robot application with two use cases: giving directions to a desired subject area/book and providing recommendations for an event/book.

4 Development

In cooperation with the library partner, a tentative design of the robot application was created, which then guided the development of a robot artifact comprising overall interaction behaviors and use case specific behaviors.

4.1 Overall Interaction Behaviors

The robot artifact should function autonomously and, therefore, activates the application if it detects a user's engagement intention. After welcoming the visitor, the robot asks whether the visitor is looking for something specific. Insights gained from another project reveal that many users do not know that the robot can understand speech. Therefore, the robot adds the remark that user inputs can be given verbally, and that the accepted spoken inputs are those written on the screen interface. In case the visitor negates the question, the robot wishes the visitor a pleasant stay. If the question is affirmed, the visitor is provided with a general overview of the different subject areas. Once the user indicates the desired area using speech or touch screen, the required use case is loaded. The behaviors for the overall interaction were implemented based on the built-in functions provided by the robot platform.

4.2 Use Case 1: Giving Direction to a Desired Subject Area/Book

The library visitor can request a direction to a subject area and the location of a book. In case of a request to a subject area, the visitor can use speech and tablet input to select the subject area. Then, the map of the library will be loading. As the external web application needs 18 s to construct the map and display the route, the robot tells the visitor a random joke to bridge the time. Once the map is loaded on the tablet, the robot uses three different communication tools simultaneously to make the route description as clear as possible: In addition to displaying the route from the robot to the destination on the tablet, the robot verbally describes the route and points in the corresponding direction using its arm.

In case of a request to localize a book, the robot asks the visitor to enter a book signature on its tablet. The directions to the target location are then displayed on the tablet. The robot signals the visitor to touch its head to exit the current use case.

4.3 Use Case 2: Providing Recommendations for an Event/Book

A recommendation is triggered after the robot finishes giving directions to a visitor. In case that the visitor previously requested the directions to a subject area, the robot verbally asks whether it should provide a recommendation for an upcoming event, which is customized based on the requested subject area. Otherwise the robot recommends a book novelty upon visitor's agreement. The recommendation will then be displayed on the robot's tablet. While the book list is maintained by the librarians, the events are obtained from the respective event webpage of the university.

5 Evaluation

As the robot artifact is intended to be used by the library visitors, the usability of the artifact is, therefore, a key indicator for the evaluation of the artifact. The following sections present the usability study and the most important results.

5.1 Design of the Usability Study

The usability study took place on-site at the FHNW CMU Library. The robot artifact was positioned in the entrance area of the library—the place, where it would be installed for the actual use.

The evaluation consisted of three tasks. In Task 1, the study participants should find out where the subject area for books on "Social Works" is located in the library and also receive a recommendation for an event. Since verbal communication is an important aspect in social interaction, Task 2 was designed to evaluate the verbal interaction of the participants with the robot. Here, the participant should accept the book recommendation. Finally, Task 3 required the participant to search for a book by entering a given book signature, which was written onto a piece of paper and placed next to the robot for the participant to read, as well as reject the book recommendation offered by the robot.

Prior to the usability testing, the participants were informed about the goal of the study, that they could withdraw from the study at any time and that they should solve the tasks on their own. During the testing, we conducted a structured observation. After each task, a short interview was conducted to capture the perception and the improvement potentials of the artifact. After the three tasks were carried out, we asked the participant about the overall perception of the presented robot application, whether they can imagine a long-term use of the robot in the library and would actually use it. Finally, the participants filled out a user acceptance questionnaire adapted from [13]. In consent with the participants, the interactions between the participant and the robot as well as the interview were videotaped resp. audio recorded.

In total, 14 university employees and students, representing the typical library visitors, were recruited for the study. The participants consisting of ten women and four men were aged between 19–57 ($M = 33.85$, $SD = 11.10$). While eight of the 14 participants have never been exposed to a service robot, three participants have seen a service robot personally before. Moreover, two participants have already interacted with resp. programmed a robot themselves. One female participant did not disclose her age and prior experience with a service robot.

5.2 Results of Task 1

Observation. Eight participants successfully solved Task 1 within a single attempt, i.e., they were able to find the subject area in the library through communicating with the robot prototype and reach the subject area physically. Ten of the 14 participants used verbal communication after the interaction was initiated successfully. However, seven participants changed to touch interaction on the tablet after realizing the verbal communication did not work smoothly. Of the remaining three participants, one participant insisted on verbal communication throughout the entire task, while two participants switched between speech and touch input on tablet. Once the robot displayed the directions on its screen and used speech and gestures to guide the participant to the desired location, half of the participants focused on the tablet that showed the route, and thus, did not react to the robot's pointing gesture. Furthermore, although two participants recognized the robot pointing in a direction, they still directed their attention to the tablet. Only five participants did follow the stretched arm as direction for the correct path.

Interview. Overall, 12 participants found the prototype easy to use. While two participants preferred speech over touch on the tablet, because verbal communication made the task more interactive and personal, two other participants preferred not to touch the tablet based on the Covid-19 situation. Malfunctioning of the voice recognition, mitigation of misunderstandings and background noise interference were the main reasons for the touch interaction with the robot. One participant liked the simplicity of the language used to steer the robot.

5.3 Results of Task 2

Observation. In total, eleven participants managed to find the desired area in the library. However, only two participants solved the task successfully by using the voice input only. Most participants encountered difficulty with the robot's speech recognition and changed to touch interaction after they repeated their voice inputs a few times and the robot still failed to understand them. The reasons for these failures were twofold: The robot failed to either recognize participant's inputs due to surrounding noises or the participant gave invalid speech inputs (e.g. speaking in the local dialect or saying something other than the given options).

Interview. Several participants explicitly disliked that the robot did not understand what they said or requested. Some participants were also unsure whether the robot understood them or not and wished, therefore, for a faster reaction in case the robot did not understand the participant. Few participants found the communication with the robot lacked the feeling of a real conversation. A potential improvement is to visually indicate whenever a voice input is possible and whether it is understood correctly.

5.4 Results of Task 3

Observation. While nine participants successfully used the prototype to display the lo-cation of the book on the robot's tablet, only two third of them did actually find the

desired book on the bookshelf. Those participants who could not find the book either remembered the wrong book information or went to the opposite direction because of the inability to read the map or going to the wrong shelf. The remaining five participants who did not manage to get the directions from the robot failed to find the text field for the input of the book signature.

Interview. For this task, nine participants found the prototype easy to use. However, eight participants stated that the text field to enter the book signature was difficult to find or too many steps to reach the text field were required. Thus, the participants suggested a search function for areas and signature entry and a clearer menu on the tablet. Further critiques included that the robot did not use gesture and speech to support the routing and should play music or stay silent instead of telling a joke.

5.5 Overall Perception of the Robot Application and Long-Term Use of the Robot

The interviews on the overall perception revealed a mixed result for the use case of giving directions. While four participants appreciated the use case because the robot used speech and gesture to indicate the direction and the map shows precise directions and descriptions, the same number of participants stated that the orientation of the map displayed on the robot's tablet was not aligned with the user's orientation and was thus not helpful to find the location of the desired area or book. Eleven out of 14 participants answered the question about the robot's pointing gesture. Five participants did realize that the robot did not use gestures to indicate the direction in Task 3. Interestingly, when asking whether the robot should apply gestures to show the route, nine participants clearly preferred the robot using gestures, while the remaining participants stated it did not matter. Moreover, twelve participants remembered a book or an event that had been recommended to them. However, only four participants could remember the content of the recommendation. While a slight majority liked the event recommendation, only half of the participants deemed the book recommendation appropriate. Further, the font size for the recommendation on the tablet should be larger.

Overall, eight participants could imagine having a robotic assistant in the library for the long run and would actually use it. Three participants could imagine the same given that the robot achieves technical and design improvements. However, two participants stated that they would not use the robot even if they could imagine a long-term deployment of the robot in the library because of their preference of interaction with humans. Finally, one participant could not imagine a long-term use of a robotic assistant at all.

5.6 Questionnaire Analysis for User Acceptance

The results of the acceptance questionnaire analysis is shown in Fig. 1. While overall, the participants well appreciated the use of the robot for the investigated use cases in the library, perceived usefulness and intention to use were only moderate.

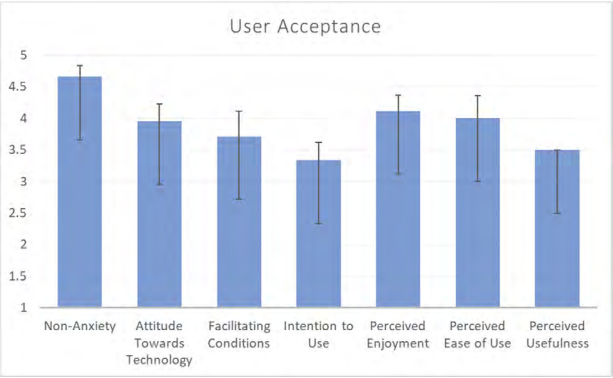


Fig. 1. User acceptance of the artifact

6 Discussion and Conclusion

The present work illustrates an ongoing project, which applies DSR combined with UCD for developing a service robot application for a library. The evaluation shows overall positive results for the proposed artifact but also identifies potential improvements, which will lead to the creation of an improved artifact version and consequently to a re-evaluation. Due to the pandemic, the next design and evaluation cycle is postponed.

In contrast to existing research on DSR (e.g. [6]), we consistently involved potential end users in all stages of the design cycle. We involved library staff in the first two phases, in which awareness of the problem was created and a solution designed, and potential robot users in the evaluation phase of the proposed artifact. This involvement of the relevant parties, together with the iterative nature of the design process, helps improve the usability and acceptance of the final robot application [7].

Methodologically, the adapted mutual shaping approach provides a structured way to learn about the librarians' ideas about robot usage and their concerns. Furthermore, the field test in the library was not only useful to test the proposed artifact with potential users but also key to reveal improvement potential and detect unanticipated problems (e.g. changing light condition due to the sunshine).

Finally, despite the limited scope of the services the robot provided, the predominantly positive attitude towards a permanent installation of the robot in the library as indicated in the evaluation is encouraging. Once the robot extends its supporting ability, we expect that perceived usefulness and intention to use will increase even more.

The present work contributes to the existing research on DSR by demonstrating the feasibility of incorporating UCD into DSR and providing insights into the applied approaches. The illustrated approach has been tested on a service robot application in a library context, which robot application designers and researchers can adapt to their given context.

To conclude, the present study demonstrates a successful application of an integrated approach of DSR and UCD to develop a service robot application in a campus library. The evaluation results suggest that the integrated approach generated an artifact that already provides benefits for both librarians and visitors. We expect increased benefits

after addressing the improvements in the next design and evaluation cycle. For future research, we plan to extend our methodology to incorporate potential end users already in the stages of creating problem awareness and of solution creation for a better user experience.

Acknowledgments. This research project was financially supported by the University of Applied Sciences and Arts Northwestern Switzerland.

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Adaptive Fashion: Knitwear Project for People with Special Needs

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Abstract. The paper investigates a fashion sector which is unexplored and ignored: Adaptive Fashion. The aim of this design is to answer to this new group of consumers creating functional and trendy garments for them. Firstly, the paper analyzes what the Adaptive Fashion was and its transformation through the years. The Adaptive Clothing companies haven't thought about a functional, creative design that follows the fashion trends and the innovations. After it shows that an accurate research was done on the physical structure of disabled people and their different requests: it studied their anthropometry and thought about a correct design process for the creation of a knitwear collection for wheelchair women. It is inspired by Milan, which won the Access City Awards 2016 prize. The collection is made of Wool and Cotton because these fibers were identified as the best natural ones for this project after a lot of scientific investigations.

Keywords: Human factors · Adaptive fashion · Disability · Knitwear collection

1 Introduction

In 2011, according to the World Report on Disability published by the WHO (World Health Organization) and the World Bank, more than 1 billion people worldwide (more or less the 15% of the world population) suffer from some disabilities.

In December 2019, the ISTAT published a report in which it analyzed the disabled community in Italy in 2017. In that year, 5,2% of the Italian population (more or less 3 million and 100 thousand people on 60 million and 590 thousand) was made by people with disability. 1,5 million was made by people of 75 years old and more. These numbers are in continuous growing and it's difficult to try to estimate them.

All the people want to be and should be represented by the fashion market but one of the biggest lack is represented by the poor supply for people with special needs. For this reason, this market segment laid claim to their role in the fashion consumption and they want functional and fashionable clothes as all the other people.

2 A "New Fashion"

Since the 40s, some particular garments were used in the medical clinics for the rehabilitation of patients, but the medical appeal doesn't represent the personality of these people. In the last years, a new term was coined: Adaptive Clothing.

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 314–321, 2022.
https://doi.org/10.1007/978-3-030-85540-6_40

With this technical term we intend:

"Adaptive clothing is clothing specifically created for people with disabilities; this could be a physical disability or invisible disability such as chronic illnesses, but in general adaptive clothing is designed for anyone who has trouble dressing. This difficulty in dressing may present itself in a person having trouble with closures (buttons, hook and eyes, and zippers) because of limited hand dexterity, trouble with "over-the-head" dresses, blouses and shirts because of limited shoulder mobility, or inability to wear pants because of uncomfortable seam and rivet placements on the butt for wheelchair users. There are a lot more nuanced and specific examples and it's good to keep in mind that the word "adaptive clothing" doesn't refer to just one type of disability or body function and type, but rather is a general term to indicate that a clothing item is made for people who do not fit the conventions of the clothing industry" [1].

Since always, clothing removes attitudinal barriers and it makes every single person more attractive and socially acceptable. In the contemporary society, disabled people have been set aside and since some years the situation has changed. This problem is typical in a lot of different sectors but it's one of the biggest problems in the fashion system: on one side, disabled people don't feel represented by this industry, on the other side this sector doesn't see them as probable customers.

The huge amount of disabilities that can coexist in a person may vary in percentage of mobility on dependency on others and it can modify the body proportions in an irreversible way. This difficulty in fall the current size category. Is one of the biggest problems for the industrialization of this type of clothing.

The growing of the disabled population needs specifically designed clothing for different reasons: some of them depend on medical devices that have to be concealed within the garment; many disabled have prominences which can create skin irritations due to the pressure on the textile, moreover infection and malodor can be present due to the long period of time in a particular position.

According to Stephanie Thomas, a stylist for people with special needs, adaptive clothing must be:

- "Accessible: easy to put on and take off on your own or even with the dresser,
- Smart: it means that it doesn't cause any harm to the body, medically safe,
- Fashionable: loved by the wearer, something that fix the lifestyle and the wearer's body-type" [2].

2.1 Historical Background

For people with special needs, clothing was for years a ready-made or an adaptation of "normal garments" to their disability. There weren't products designed for them and this situation created a huge dissatisfaction. In the early part of the 20th century, applied research was carried out to explore the relationship between clothing and rehabilitation practice.

In the 1930s, the aspects of donning and doffing became an important part into the treatment programmers in hospitals and clinics especially for patients with cerebral disability, and during the 1940s the disability research continued to change. In the 1950s, some designers, such as Mary Brown, started to design specialized garments for specific

population combining functionality with fashion aspects. Another name is Helen Cookman, a designer who notified the lack of proposal in the fashion world, for the disabled. Starting from the 1970s, the attention was focused on the construction of the adaptive clothing rather than the fashionable ones. In the 1980s, the attention was turned towards fashion and its psychological component because adaptive fashion had to be a way to express people, as the fashion is for "normal" people. This period of applied researches produced a lot of lists and explanations of styles, constructions, details and adaptations for this type of garments. In 2007, Caterina Radvan understood that "clothing designed specifically for the disabled was largely for the convenience of those administering care, and that the "dated" designs emphasized a social and personal stigma in which the wearer felt "out of date" and by association "out of circulation" [3].

She identified two different types of clothing spheres: expensive and bespoke or cheaper but not fashionable and oriented to practical garments.

In 2014, the first disabled model who trod the board was Danielle Sheypuk and after this event, a lot of different brands hired disabled people for the Fashion Week. Tokyo, Paris, London, Rome, Milan are just some of these cities.

2.2 Adaptive Fashion in the High-End Fashion Market

The fashion world is a remote universe for disabled people, in which they don't find clothing that fits well and which is comfortable, aesthetically pleasing, affordable and accessible at the same time. Over the years, the high-end fashion brands have never been interested in this new type of consumers. The clothing for disabled was unfashionable, ugly but practical and these features excluded these people from the fashion process, underlining their social marginalization. In this context, the mainstream fashion system continues to ignore these various necessities, because it works on a mass-market model, in which the only possibility to express yourself is through style, color, size and fabrication.

Related to fashion, people of Western society follow precise standards of beauty in which women must be tall, slim and beautiful, men must underline their masculinity and force. For people with special needs, clothes and the fashion system had become an oppression and for this reason fashion increases the perception of disabled as "outsiders".

Many people and brands, who want to invest and distribute adaptive clothing, have experienced a disappointment in finding that:

- it's difficult to reach this market segment;
- maybe it's not as large as they would expect, in relation to the whole market;
- this market segment is considered as not exchanging money.

Starting from these three points, high-end brands continue to marginalize these consumers because they have to challenge their abilities and because they are afraid of perception that these consumers can have if they do something wrong in this new area. In fact, when designers have to create an adaptive collection, they have to consider ergonomics, comfort, accessibility and the aesthetic aspect. Regarding the ergonomics, a lot of brands don't have experts in this field in their industry so, to solve this problem,

they give this role to a non-specialist, without the necessary support (education, facilities, research networks). One of the most famous disabled fashion styling, Stephanie Thomas in an interview for TEDxYYC, affirms that the proposal for this category is none because "You can't market people you don't see. And you just can't see people you don't value".

According to her, fashion doesn't answer to these consumers because there are some barriers: people with disability are all the same; design is too difficult and people with disabilities can't effort it.

Moreover, there is a "core consumer" linked to every single brand: a hypothetical and ideal consumer, which embodies perfectly the brand's DNA. Often this ideal figure is totally opposite to the disabled one which is seen as an "outsider" and it isn't even considered. To include them in the fashion process is something that can undermine the idea of beauty and perfection that the high-end brands want to share through their collections.

The results are practical garments with medical appeal and far from the beautiful articles of clothing shown in the catwalks, which have constantly to choose between form and function. Fashion brands with the runway events and their collections are selling a lifestyle, a vibe, an idea: they exclude disabled so that it seems that brands don't see disabled people as attractive.

3 "Disability": Evolution, Analysis and Measurements

3.1 Evolution of the Concept of Disability

In Human history, handicapped people were considered "the inferiors", those people destined to be erased or excluded by society. Often this condition of mental or physical diversity was a cause for mocking, derision or marginalization, as it was an uncomfortable and embarrassing condition for both the families and those affected. Through the millennia, disability was perceived and treated in very different ways. The anthropologist Claude Lévi-Strauss identifies abnormality and impairment (what we call psychomotor disability) as elements which are the foundation, and not only, of the Western Culture [4].

During the Stone Age, man tried to declare his superiority over other animal species establishing himself as the dominant specie. The primary aim of the early tribes was survival, with the exclusion of those figures considered as a danger for the entire group. In the Code of Hammurabi, there is a distinction between "good disabled" and "bad disabled": the first ones were assisted by the State because they were affected by infirmity in a completely random way, the second ones were the mutilated culprits by the Law of Retaliation. During the roman-era, disability was considered as a reason for abandonment but above all for elimination. In Sparta, the newborns affected by deformity were abandoned in a cave, called Apoteta, on the Taigeto Mountain, a peak that rises behind the city. The infants were left at the mercy of the weather and the ferocious beasts that inhabited the area, sure that they would surely have died.

Despite this fact, we know that in some city-states the first form of public welfare was created, especially for physical disabilities, but care and integration were reserved only for those from the upper classes.

3.2 Anthropometry and Analysis of the Disabled Body

Thanks to the anthropology and the anthroponomy and the psychical and physical characteristics, it is possible to divide the worldwide population in three groups:

- people of high efficiency;
- people of "normal efficiency";
- disabled people: this category includes all the different types of disability, starting from the physical to the psychical ones.

Each group has a particular somatic structure, so it creates a lot of problems in the production of adaptive clothing. The deformation of a disabled body can be influenced by the deformities of the osseous system, because sometimes it's really difficult to maintain the correct straight position. The disabled body is totally different from the able body, but it's arduous to create a general measurement for the body of people with special needs because the disability modifies their body in an irreversible way.

For the general measurements it's important to underline three factors:

- when the disability afflicts that particular body;
- how serious the disability is;
- the degeneration of the pathology.

Different methods, with a variety of methodological approaches, are used in the measurement, moreover a special measuring equipment is used.

4 "Adaptive Clothing": From the Fiber to the Design Process

The best natural fibers that can be used for adaptive clothing are wool and cotton.

Cotton is a plant cultivated since millennia thanks to its characteristics. It's a soft natural fiber that grows around the seeds of the cotton plant, it's biodegradable and recyclable, really soft and highly absorbent. It's natural breathable and it can absorb moisture and in a second moment it repels it. It's a non-allergenic fiber and it's perfect for people who suffer from skin irritation.

Wool "is an organic compound of keratin, an animal protein that is also found in hairs, nails, feather and horn. A distinct from hair or fur, wool has many tiny overlapping scales, all of which point in the same direction" [5].

It has a lot of characteristics: it's a natural fiber, biodegradable and renewable. It's naturally breathable, thermal reactive and odour resistant. Wool is naturally elastic, stain, fire and UV resistant. The Woolmark Company is the biggest productor of wool worldwide and it demonstrates that "wearing Merino wool is therapeutic for eczemas sufferers" [6].

These two natural fibers are the best for Adaptive Garments.

The creative process is different for this type of fashion. After numerous studies, some designers decided to try to answer the continuous and growing demand of the disabled: being represented by the fashion system. In this way the adaptive fashion was born. The most evident characteristic is the construction of clothes. Starting from the

commercial patterns for the abled bodies, it's possible to modify and create the patterns also for the disabled as mentioned before, but we need to take in consideration some different needs that these consumers have.

To increase comfort and ergonomics adaptive designers made some important changes in the construction of patterns. For example the waistline level is higher in back and lower in front than in standard pants, little buttons are replaced with automatic ones, or with Velcro Stripes. Gussets are stitched in particular areas to reduce pressure sores, pockets have to be located in direct line with the hand that use the pocket and they have to be easy to use.

5 Milan on "Fashion Wheels"



Fig. 1. Moodboard inspired by Milan City

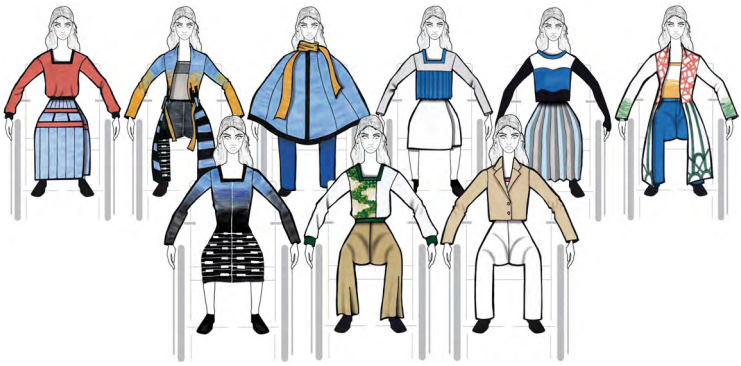


Fig. 2. Milan on "Fashion Wheels" Collection

The beauty of a city, such as Milan, lives in its contrasts. It's a city of contrasts but it is also a city with thousand opportunities. Milan opens its arms to the future and it becomes the main inspiration for a colorful Adaptive Clothing Collection. It is made for a disabled feminine public who doesn't want to be marginalized by the society for its diversity. It's in knitwear and it tries to combine the functional aspect to the aesthetic one, which has always been denied to this market segment by the fashion system (Figs. 1, 2 and 3).

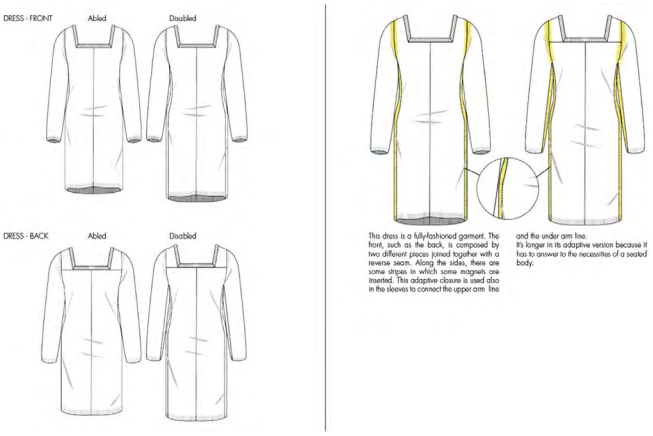


Fig. 3. Example of the jacket modification, from the abled body pattern to the disabled one.

In the collection there are some of the most significant garments that every single person wear. Jackets, trousers and dresses are garments to have in the closet of each person, abled or disabled. After all the researches, these are the most difficult garments to adapt and to design for disabled people by the brands. For this reason a long research was done on the classical abled body pattern to understand how to convert them into the ones for the disabled bodies (Fig. 4).

Working on adaptive clothing could be, in addition to a personal challenge (in the field of design), a smart investment also because the demand is very high and the offer is almost non-existent. The starting point has been written but it will be the care of future designers to combine beauty, fashion and accessibility.

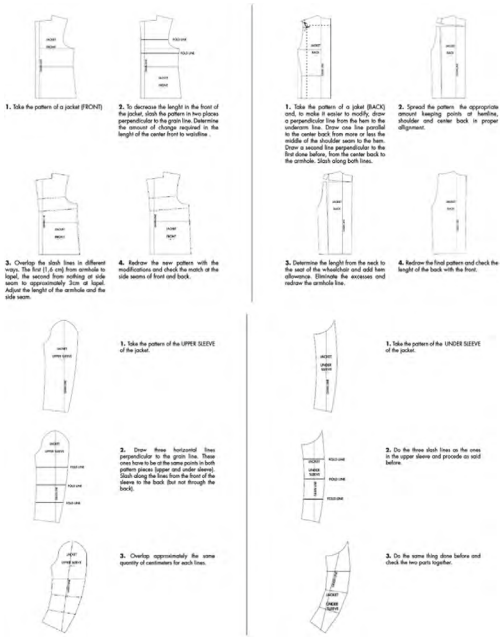


Fig. 4. Example of the jacket modification, from the abled body pattern to the disabled one.

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Communication Needs Among Business Building Stakeholders

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Abstract. In a business building, different stakeholders communicate with each other frequently. It is important to understand their communication needs to be able to develop smart building solutions to support the communication. Our study focused on an entrepreneurial business campus that hosts start-up companies, investor companies and service providers. As data collection methods, we used interviews complemented with one-week diaries. In total, we interviewed representatives of ten different stakeholder roles. Especially important contacts as well as communication needs related to providing services were studied. As a result, we present how these professionals currently communicate with each other and what communication needs they have. These findings can be used when defining communication requirements in the development of smart solutions for business campus buildings.

Keywords: Human factors · Communication · Building · Ecosystem · Services

1 Introduction

Business building is a building with offices; and business building campus is a set of buildings for some shared business related purpose, in a defined area (cf. the definition of Merriam-Webster [1]: "the grounds and buildings of a university, college or school"). Business ecosystem, in turn, has the major characteristics of (i) symbiosis among its parties as the survival of each party is based on the benefit of the ecosystem as a whole; (ii) a common platform that they share – services, tools, or technologies -, and (iii) co-evolution, which is realized in the synergic cooperational value that is greater than the sum of its parts [2].

Business building campus can form an ecosystem in which its elements – humans and the immediate environment – function together, sharing a common business related purpose, forming an entity with equilibrium (confer the definition of biological ecosystem as described by Jackson [3]. Business building ecosystem can be defined by both business and buildings – the value of the buildings or campus is more than the value of the sum of its buildings. Partners in the campus create the mental core of the campus

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 322–330, 2022.
https://doi.org/10.1007/978-3-030-85540-6_41

and being located in the campus raises the value of its partners. Thus, the location of business in the same campus raises the companies' value in business.

Advanced functioning building can be defined as a building with energy consumption minimized and the performance comfort and satisfaction of its occupants maximized [4]. Smart building is a building, which integrates and accounts for intelligence, enterprise, control, and materials and construction as an entire building system, with adaptability at its core [4]. A business building campus would benefit from being smart as then, in addition to being managed in an efficient, flexible and satisfying way from the material perspective (intelligent energy consumption, air conditioning etc.), the same campus can foster and raise the feeling of community and give rise to new innovations and perhaps even enterprises.

Communication is the means to make decisions together as well as build contact among people. To keep an ecosystem functional and coherent, communication is needed. Furthermore, communication has been found as a prerequisite for an innovation ecosystem to thrive [5]. Smart communication is part of being smart campus.

This paper is about a business building campus in which old campus buildings (previously, not related to business) are renovated to meet the demands of startup companies' offices. Also new buildings are being built to new companies within the campus. Campus offers services to all its customers (startup companies accepted to the campus). The creating of the sense of community among campus companies is an openly expressed objective to be maintained and raised in the campus. In that sense, it is an ecosystem and the fact it locates in a unique environment raises its value. This is commonly acknowledged as the campus receives constantly visitors around the world.

The target of the paper is to shed light on the various communication needs that are related to a business building campus, based on an existing campus, and reflect them further from the perspective of smart campus ecosystem. The interviews among campus representatives were conducted before corona, which explains why face-to-face meetings are mentioned so frequently in interview results.

2 Methods

Participants. We collected data by interviewing stakeholders - 10 stakeholders - and collecting their diaries (7 diaries). Diaries were collected only from those who were first identified as key people to interview, not from those who were later identified as equally important to interview, so all interviewees did not fill in the diary. All study participants were involved in developing, running, or using the business campus.

Data Collection. The interviews lasted for about 1–1,5 h. Regarding the questions relevant for this study, the questions were about the general content of work and the contacts needed at work. The diaries included, among other things, a graph to fill in about business contacts and the meeting frequency of those contacts in four categories: daily, weekly, monthly and less frequently.

Data Analysis. Interview data was analyzed by utilizing the comments that related to business needs and communication. Diaries were used for creating an overview about the building related contacts and their frequency; the categories of 'monthly' and 'less frequently' were combined.

3 Results

Based on the interviews, this section describes communication practices that the business building campus stakeholders have; see also Table 1 for communication contacts and their frequencies, based on interviewees' diaries.

Tenant; Campus Company Representative. Startup companies are main users of the business building campus. The business of the interviewed small expert company is to facilitate the familiarization and collaboration between the solution-seeking company and the solution-providing company, in the context of co-creation; part of also co-creation is performed at campus office.

Work requires extensive networks. Still, in daily and weekly contacts, own team, campus people and customers are the ones who are met, and other experts are contacted less frequently. The business campus companies provide an opportunity to contribute each other's' work but without the easily accessible information, this has and will not be realized. According to the tenant example, there is a sense of communality in campus, but genuine community could function even better with more free-format tools.

CEO, Campus Management. The office of CEO locates in the campus. The main task of CEO is to create vision and strategy for campus management and marketing purposes. It is essential to build and maintain the sense of community among campus tenants and to maintain and increase campus value based on how interesting it is perceived. For tenants, the work is about providing a common platform to facilitate campus' internal activities, in the form of, for example, information channels, restaurant and events. CEO takes care of contract related matters with campus companies and other bigger questions and CEO also welcomes guests and delegations, a task, which takes a lot of time.

Practical ways to proceed are defined in own team meetings; only own team and campus people are the ones who are met on daily basis. Contacts with investors, city representatives and Startup Foundation take place weekly.

Community Manager. In the beginning, when the campus started to fill in with startup companies, all processes and rules had to be established. The task was, then, first to build a system to manage community related matters, starting from arranging the arrival of new startup companies to the campus with feeding the needed information to the system. Simultaneously, the work was and is constantly about dealing with short-term problems the tenants have – lost keys, broken window, and the like. If some team wants to visit the campus, the manager organizes accommodation as well as somebody to walk them around the campus. When an event is approaching, its location needs to be defined, the technology must be familiarized and made optimal to the situation. Work relates to members of the community, partners, visitors and sometimes even intruders, and the main communication channels are a proprietary business communication platform, e-mail, and face-to-face meetings.

Community Team Member. Core task is to answer questions posed in reception. To do the work, it is essential to know what companies belong to campus, to know the work process related to own work and to know the different tools and folders used in the system. The most frequent tasks are sorting the mail, registering visitors, and receiving

and solving requests and complaints and redirect them to the responsible person if needed. Communication is in the form of physical encounters, and a proprietary business communication platform is also used. Work takes place in constant haste. Contact is to campus members, own team members, visitors, and people related to renovation and services such as restaurant and maintenance staff. Things get best handled with direct contact to people.

Facility Manager. The work is about renovating office spaces to suit the needs and preferences of the new arriving startup company or a company that has grown and needs more space. The renovation focuses on new meeting spaces, phone booths, specific types of carpet, water outlets etc. The most demanding issues are renovations that deal with the main structure of the building such as bulkhead or water piping. Additionally, small problems are solved, such as a window is broken, or electricity is off at some location. The customers are campus companies and communication is mainly conducted with meetings and phone calls, as well as with a proprietary business communication platform [Slack] and a fast messaging platform [WhatsApp]. The site is city owned and if, for example, more lighting is needed, it is a process with the city. Also more demanding renovation is subcontracted such as plumbing and electricity related work, which requires the related discussions and formalities.

Cleaning Service Manager. The aim is to provide the customer the best possible cleaning service. A new challenge and trend at work is that nowadays, customer expects immediate communication and the related actions, meaning that the point in question needs to be cleaned at once. Customers also have different requirements, such as the usage of ecological cleaning substances. Regarding campus related contacts, cleaning manager communicates with cleaning personnel about everyday cleaning related issues and with customer about issues in cleaning (cleaning feedback) and conducts quality inspection with customer representative. Customer has organized and paid waste management for the waste gathered through cleaning and the supplier for the cleaning company brings the ordered items directly to customer site. Supplier drives all needed cleaning material directly to the campus.

Real-Estate Developer/Owner Representative. The work of a real-estate developer means dealing with several building project simultaneously, participating or managing building projects in various phases in the building lifecycle (planning, construction, commissioning, maintanence). Profitability of the building project is in the core of the work and each project lasts for several years. It is also essential, what benefits the user of the building and how it can be developed. In the context of present study, the interviewee represents one of the main owners of the business campus, with the additional specific questions of how the concept endures time, how to maintain flexibility to changes in the buildings, and how to provide modern working spaces in mind. Information and fluent communication are essential prerequisites for successful work and the network of building related professionals is extremely important. Information is acquired by from media, newspaper or perhaps a phone call. Both casual and formal contacts are important for network building. The building of a communication network is constantly ongoing, including site owners, investors, constructors, users –stakeholders who can contribute to planning and construction.

Campus Project Manager. Campus project manager serves campus companies by acting between the companies and the city, which owns the campus and is responsible for the buildings, both old and new builds, and is also the employer of the manager. The work is a lot of about trust, which is built with personal relationships and personal encounters. Campus project manager constantly communicates with the city architect and builders about renovation planning and performing the renovation. Once a month, a meeting is held to campus startup companies about what renovations will take place next and updated information is provided frequently with a proprietary business communication platform. The companies appreciate that communication is trustworthy and that actions are fluent and rapid.

Project Manager, Construction Contracting. The manager, employed by a building trade company, has the task to plan and manage the work at the construction site in the campus, related to office spaces. Planning has a central role; work includes building project planning, proposal planning, general planning, planning for building permit, and finally realization planning. Customers in the business campus provide the preliminary plans and the project manager refines the plans according to what is possible and feasible. Customers do not always really know what they want so also such matters may need to be contemplated together, often with visualization tools for 2D and 3D models. The basis for work is collaboration with several parties – for instance, planning of the building is subcontracted and the actual construction work can be made in own organization or bought from elsewhere. The work can begin with customer needs or, alternatively, with own investment so that customers are sought after later. Planning requires a lot of communication among all stakeholders and when at the construction phase, work supervisor is collaborated with too, in addition to, for example, with those responsible for procurement and HVAC professionals.

Project Manager, Electricity Design. Timetable, resource management and the acquiring of real and relevant basic data are in the core of the work. The work consists of a lot of meetings as building related decisions are to be made and the electricity related information must be mediated to team of the same company, planning electricity to buildings. Work includes the planning of both new-builds and renewals. To make appropriate plans, also other domains need to be understood, such as the work of architect or the ones of HVAC professionals. Interpersonal skills are important, one needs to be able to express own ideas and to get along with different kinds of people. Many matters are interdependent and in planning, the interests and boundary conditions must be taken into account. In planning, information must always be updated as the plans are not always realized as agreed on. In the business campus, the work is related to new-builds and renewals.

Table 1. Interviewees' contacts and their frequencies as reported by interviewees

Interviewees	Contacts		
	Daily	Weekly	Monthly/ Less frequently
Tenant, startup company representative	Own team; other campus members	Customers	Other experts in the field
CEO, campus management	Campus community team; tenants; business partners	Investors; city administration people; Startup Foundation; city service to help new businesses and startups; campus board of directors; open innovation space inside the campus	Politicians
Campus community manager	Various campus members; colleagues; visitors of members	City administration people; workers	
Community team member	Campus staff; campus members; postal services; restaurant people; random visitors	Renovation and maintenance services	Foreign delegations
Real estate developer, owner representative	Real estate development partners; campus; key builder representatives	Real estate projects' investors, builders, architects; expert consultants; city representatives (land office, town planning, building permit, etc.); partner network; campus design team; campus network	New projects/Network teams
Project manager, construction contracting	Other project members and support functions; project development; accounting	Designers; investors; authorities; users; site personnel; owner/Owner representative	
Project manager, electricity design	Colleagues	Customers; contractors	

4 Discussion

The various roles around the business building campus and their main communication needs and communication contacts were presented in Results. Contacts with the members of own organization were emphasized. Naturally, these contacts are the easiest to establish and maintain. The frequency of contacting people in the campus depends on whether own workplace is in campus or outside of it.

When focusing on communication with and within the campus, the picture becomes more complicated (see an overview in Fig. 1). Communication probably takes place among tenants, but it could be intensified; communication among all working at the campus (tenants and professionals whose work is to only support the campus) is direct but probably could be more emphasized; professionals whose work is not concentrated on campus only, mainly communicate with inside-campus professionals. Even if the work affects tenants directly, such as cleaning, the contact is between other campus professionals and the cleaning company.

The communication can be direct, like when tenants visit the reception with their problems, or mediated, like when a building related company receives a task of renovating something for a tenant in the campus. Furthermore, the need to communicate can be daily or less frequent; the urgency of receiving a response varies; and some features in communication, such as part of mediated messages, are probably due to communication practices and means and not based on needs. These various communication needs could benefit from well-designed communication platform that would enable the sending and receiving various types of messages, both human originating and those, which have a sensor as the source.

Regarding a smart business building campus, all the presently existing communication channels can be replaced with more effective ones. For instance, in the optimal situation, tenants can be easily and flexibly be related to each other and maintenance related organizations can get the needed information about the issues and development needs efficiently through, e.g., sensors, and vice versa, tenants can report about issues easily and be sure that the message is received. Already this brief description illustrates how a smart business building campus – or any smart building – requires both well designed and easy-to-use communication platform and well-defined and realized work processes that ensure that the messages do not get lost but are handled in due time, including access rights, predefined formats when needed, automatic processing of sensor data etc.

In the interviews, face-to-face contacts were found important. Now that COVID-19 affects daily life, these contacts have become a rarity and this trend may remain also in the future. This may raise the importance of digital communication. In the future, building related information may become an asset – the better the brand of a building ecosystem or the one of a set of buildings, or a campus, the higher value for the information that runs in this ecosystem. This information may become something to sell. Various professions need extensive networks and finding interesting parties in building ecosystems is one source of information; and tenants' satisfaction about some building related solution, reflected in tenants' behavior or expressed opinions, may be highly interesting to parties whose work is related to the same kind of solution. Belonging to some building ecosystem may become highly appreciated for a good reason; and having access to building related

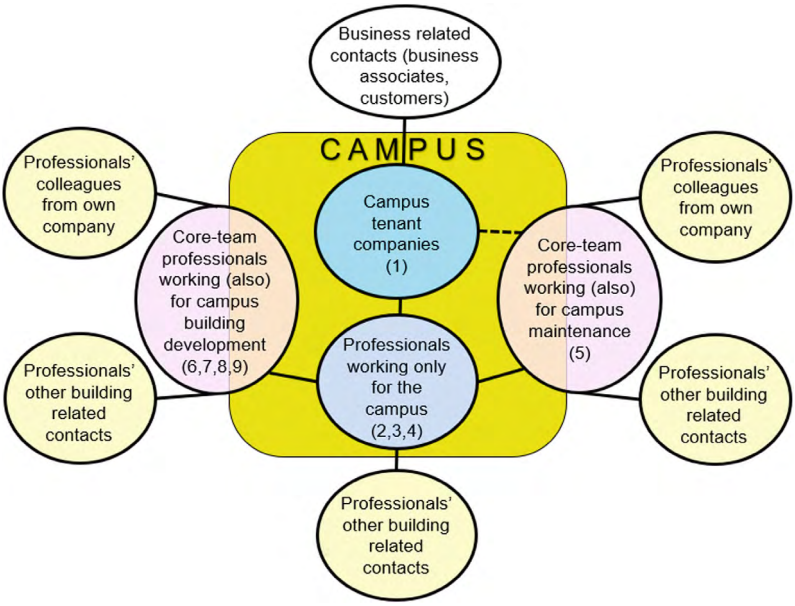


Fig. 1. Communication contacts related to different campus related groups. Focus group is the one of tenants whose working place is campus (number 1). Professionals whose employer is campus are CEO (campus management), Community manager, Community team member and Facility manager (numbers 2–4). Maintenance related companies have here the example of cleaning service company (number 5), and professionals whose work is related to developing the campus from the campus building perspective are owner representative, campus project manager, and project managers of construction contracting and electricity design (numbers 6–9). The order of appearance is the same as used in Results.

information can be valuable to business, not only one's own but also to other companies working in the same field.

5 Conclusions

The present paper supports in understanding what communication needs and channels presently exist in a business building campus and provides basic information for defining communication requirements in the development of smart solutions for the campus.

The situation is simpler when dealing with a campus with no new building plans and construction work. However, the complexity does not only depend on the quantity of parties but on the quality of messages to be sent; for example, the same information can be sent to several parties but processed according to the needs of the receiver.

Thus, the data about the users and their communication is only a starting point; the next step is to expand the planned communication network by identifying the information needs that are not realized in present solutions, and perhaps not even understood yet.

Acknowledgments. The work was carried out in KEKO project, funded by Business Finland and the project partners KONE, Nokia, YIT, Caverion, Halton, Netox and VTT Technical Research Centre of Finland Ltd. The authors want to thank the interviewees from the studied business.

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Reduction of Electrotactile Perception Threshold Using Background Thermal Stimulation

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Abstract. Electrotactile displays reproduce tactile properties of an object such as texture and shape to provide feedback in human-machine interactions. Electrotactile perception threshold (EPT) is a critical psychophysical parameter in designing a safe display as prolonged usage causes skin irritation. This study's main objective was to reduce EPT with background thermal stimulation (BTS) and analyze the qualitative and quantitative aspects of EPT with and without BTS. A psychophysical experiment was conducted to measure EPT with and without BTS (+7 °C)) over a wide range of stimulus frequencies of EPT from 20 Hz to 640 Hz. Findings from these experiments showed a reduction in the EPT (ΔEPT), which was 13% to 17% (with an average of 15%). Reduced EPT may provide safer and comfortable electrotactile displays for prolonged usage.

Keywords: Electrotactile display · Reduction in EPT · Electrotactile Perception Threshold (EPT) · Background stimulation · Thermal stimulation

1 Introduction

The human sensory system comprises five senses: Vision, auditory, touch, smell, and taste. Touch is one of the primary senses where the receptors are spread over the whole body and located beneath the skin, further classified into tactile and kinematics. The tactile sense is responsible for enabling us to perceive shape, texture, pressure, stretch, and vibration. Four mechanoreceptors lie in the epidermis and dermis layer of skin: Merkel, Meissner, Ruffini, and Pacinian corpuscles [1–3]. Two more feelings are associated with touch sense: Warm and cool perception. Two different cold and hot receptors are located beneath the skin, separating pathways for cooling and heating [4].

The tactile properties can be rendered using two different interfaces: vibrotactile and electrotactile actuation of the mechanoreceptors and nerve endings. These interfaces find themselves useful to generate surface properties (texture/roughness) and as a feedback system in the human-computer interfaces. Electrotactile displays use a pair of electrodes (surface electrodes or microelectrodes) to pass the current through the skin, which activates the nerve fibers to produce tingling, pressure, or vibrations [5, 6]. These displays are compact and doesn't undergo mechanical wear and tear, unlike vibrotactile displays. However, few limitations of these electrotactile displays are skin irritation and burn with

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 331–338, 2022.
https://doi.org/10.1007/978-3-030-85540-6_42

prolonged usage [7, 8]. Such restrictions can be avoided or reduced if the threshold for electrotactile displays could be reduced.

The thermal sensation is a part of the sense of touch; however, the sensation is slower than the vibration, and other tactile sensations [9] have suggested a method to make it perceivable faster using a novel parameter called "temperature change" instead of temperature alone. Thermal displays are used to render temperature gradients in virtual environments [10, 11]. One major limitation of thermal displays is the weak localization of the stimulus. They have a narrow range of comfortable temperatures (15 °C to 45 °C), and it induces pain sensations over this range for most of the subjects. For some of the subjects, the range is even narrower [12].

The user's safety while using electrotactile displays must be considered seriously to avoid any user discomfort which restricts the current to a certain value. According to literature the current between 18 to 22 mA can induce pain and sometimes muscle fatigue as well. The currents above 30 mA may cause respiratory paralysis sometimes. For an average adult human being, the current between 75 to 400 mA may cause ventricular fibrillation. Olson *et al.* [13] have studied the thresholds for electrotactile displays and according to their findings, at 60 Hz AC stimulus, the EPT is 0.5 mA whereas for DC if the surface is wet, EPT varies from 2 mA to 10 mA. A typical EPT when the electrodes used were of 10 mm^2, lies between 20 to 30 mA which depends on the skin properties. In order to reduce the thresholds for electrotactile displays, new methods need to be studied [14].

This study's main objective is to present a method to reduce thresholds for electrotactile displays using background thermal stimulation. This study intends to interfere with the design choices and implementation of the electro-tactile displays to overcome the limitations like skin irritation and other discomforts when subjected to prolonged usage. We focus on studying the threshold characteristics under two conditions (first at room temperature and second when the BTS is applied) to study the thermal stimulation effect on EPT.

2 Experimental Design and Methodology

A psychophysical experiment was conducted to measure the EPT on the middle of left forearm to study the superposition of electrical and thermal stimulation to investigate the reduction in EPT. This experiment was conducted in two stages. In the first stage, EPT was measured at room temperature; in the second stage, ETP_T was measured in the presence of thermal stimulation.

2.1 Experimental Setup

The setup for electrical stimulation was made using basic components. Two Ag/AgCl electrodes were attached at the middle of the left forearm, working as anode and cathode, respectively. We used a function generator to deliver square wave pulses with a 20% duty cycle. This function generator was capable of adjusting the amplitude, duty cycle, and frequency of the stimulation. For the experiment's simplification, the duty cycle was fixed at 20%, and amplitude was adjusted to measure the EPT at different fixed frequencies.

Frequencies were selected using a logarithmic scale having a 3 dB difference between two consecutive frequencies, and the selected frequencies are 20 Hz, 40 Hz, 80 Hz, 160 Hz, 320 Hz, and 640 Hz.

An infrared lamp (150 W, 230 V, and 50 Hz) was used to deliver thermal stimulation. A conical frustum made from cardboard was used with a base radius of 6 cm and a top radius of 2 cm to focus the spread of infrared light waves. The radii of the frustum were chosen according to the size of the electrodes (10 mm diameter) and distance between the electrodes (20 mm), which was necessary to avoid excessive heating in other parts of the skin. The setup for thermal stimulation and lamp along with focusing conical frustum is shown in Fig. 1a and Fig. 1b, respectively. A radiometric camera (Sonel KT-150) was used to measure the skin temperature. It records the temperature at each point of the image captured with an image refresh rate of 50 fps. The lamp heated the skin by seven °C in 30 s (as measured by the IR camera).

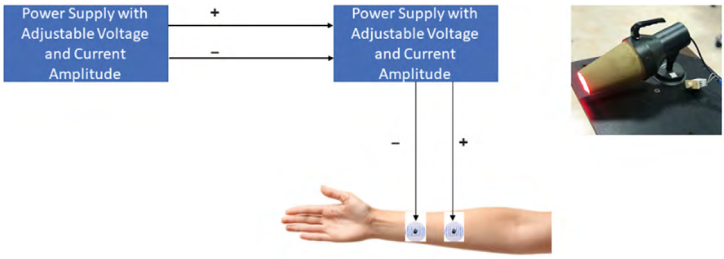


Fig. 1. Schematic for electrotactile Displays with two ECG electrodes and a IR lamp is shown which was used along with a cardboard conical frustum

A rise in the temperature of the skin was used in the current study instead of the temperature of the skin itself since the skin temperature of each participant was different, although the room temperature was maintained at 25 °C. The participants' range of skin temperature was 34.5 °C to 36.5 °C, which may be due to the circulatory system that maintains the individual body temperature.

2.2 Experimental Protocol

This experiment was conducted in two stages: In the first stage, the EPT was measured at room temperature. In the second stage, EPT was measured when the skin temperature was raised by 7 °C.

Subjects. Seventeen healthy subjects (eleven males and six females, 24 ± five years) participated in the experiments. Subjects were recruited voluntarily from the university. Experimental procedures were briefed to the participants to acquaint them with the study. The concept of threshold and staircase method was explained to them. Subjects wore blind-fold and noise-canceling headphones to avoid interference from the ambiance. The temperature of the room was maintained at 25 °C by an air conditioner. The left forearm is chosen to keep the stimulus location consistent for all the participants.

Experimental Method. The order of the two experimental stages was randomly selected for each subject with or without BTS. The frequencies for electrical stimulation were chosen randomly and applied to participants to avoid bias. Room temperature was maintained constant at 25 °C and monitored manually with the IR camera.

In the first stage, the electrical stimulus was rendered using Ag/AgCl electrodes, and the perception threshold was recorded using the classical psychophysical staircase method. In this method, the stimulus was increased or decreased progressively, and participants were asked to respond as "Yes" and "No" representing the presence and absence of stimulus, respectively. Whenever a participant responded, the direction of staircases was reversed, and the stimuli amplitude at that point was recorded. This method was repeated five times to generate ten transition points at each frequency. The EPT for each frequency was calculated by averaging these ten threshold values.

The stimulus frequency was chosen first, and then the amplitude of the stimulus was adjusted to reach the threshold point. Amplitude was started from 0 V and increased in the step of 1 V until the subject responds as a change in perception to the stimulus. After that, the step was chosen as 0.1 V to improve the resolution of the experiment. From 20 Hz to 640 Hz, this procedure was repeated to find the EPT at all the chosen frequencies.

In the second stage, EPT_T was measured in the presence of thermal stimulation on the skin. EPT was measured at six different frequencies (20 Hz, 40 Hz, 80 Hz, 160 Hz, 320 Hz, 640 Hz). At the start of the experiment, the infrared radiation's intensity was set such that the skin temperature rises to the desired level (i.e., seven °C). Thermal stimulation was then provided for 30 secs, during which the ten transition points of the electrical perception at a given stimulus frequency were measured using the staircase method. It was assumed that the temperature of the skin remained constant for this duration. The skin temperature was monitored using an IR camera during the experiment. The procedure to measure ten transition points was precisely similar to the first stage of the experiment. The EPT was taken as the average of these ten transition points.

After the measurement of all perception threshold values, the experiment was paused until the participant's skin temperature was restored to normal room temperature before the next trial (about two minutes) to maintain the skin's uniform temperature in each trial. It took 15 min for every frequency for ten trials, including the two-minute time gap, to restore the skin temperature. Therefore, the whole experiment was completed in approximately ninety minutes for a subject, measuring the EPT and EPT_T at all six frequencies.

Relating EPT and Temperature. An additional experiment was conducted to evaluate the linearity in EPT change with the change in temperature (3 °C, 5 °C, and 7 °C). Two subjects were chosen randomly from the seventeen subjects participating in the previous experiment, and the EPT measurement protocol was repeated for each temperature. The setup and experimental methodology used were similar to the previous experiment. EPT_T was measured by checking the threshold at room temperature, then by increasing the skin temperature by 3 °C, 5 °C, and 7 °C, respectively. It took two hours and thirty minutes for one participant, and this was the primary reason this study was not conducted on all the participants.

3 Results

This Section presents the results and analysis of the psychophysical experiments conducted in order to prove the hypothesis. Figure 2 shows a comparison of EPT and EPT_T for seventeen subjects. In other words, EPT at room temperature and EPT after heating the skin by 7 °C, as shown in the figure. In this plot, EPT and EPT_T were normalized with respect to the EPT at 20 Hz. The EPT plot followed a V-shaped pattern. The reduction in the EPT (ΔEPT_T) is from 13% to 17% (with an average of 15%).

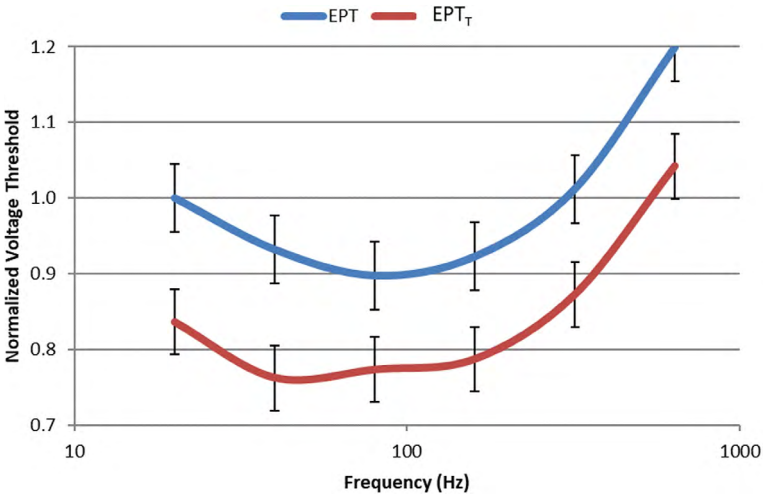


Fig. 2. Normalized EPT and EPT_T for the average of 17 subjects is plotted against the frequency. Where the top curve represents the average EPT of electrotactile stimulus at room temperature, and the bottom curve represents the average EPT_T (at room temperature + 7 °C).

A two-way factorial ANOVA test without replication has been conducted to test the null hypothesis between EPT and EPT_T of Fig. 2 statistically. Test results for the average EPT of all the subjects are shown in Table 1. There were two null hypotheses: one for the method and the other for the frequencies. For the method, since the p-value for the rows (across the frequencies) = 2.08E-05 < .05 = alpha (or F = 145.42 > 5.05 = F-critical), we rejected the null hypothesis. In other words, the confidence level is more than 95%, and we concluded that the EPT is significantly different than the EPT_T across the different frequencies. Therefore, the changes in EPT with BTS are statistically significant. We have conducted the same test on individual subjects' data as well, and results show a significant statistical difference.

Figure 3 shows a further reduction in the EPT with an increase in temperature (3 °C, 5 °C and 7 °C). In this figure, Vth −20, Vth −40, Vth −80, Vth −160, Vth −320, and Vth −640 represent the EPT at 20 Hz, 40 Hz, 80 Hz, 160 Hz, 320 Hz, and 640 Hz, respectively. The graphs show a continuous decrease in the EPT with the increase in temperature, although the reduction in EPT is non-linear.

Table 1. Anova test

Source of Variation	SS	df	MS	F	P-value	F crit
Rows	13.41	5	2.68	145.42	2.08E-05	5.05
Columns	7.69	1	7.69	417.09	5.21E-06	6.60

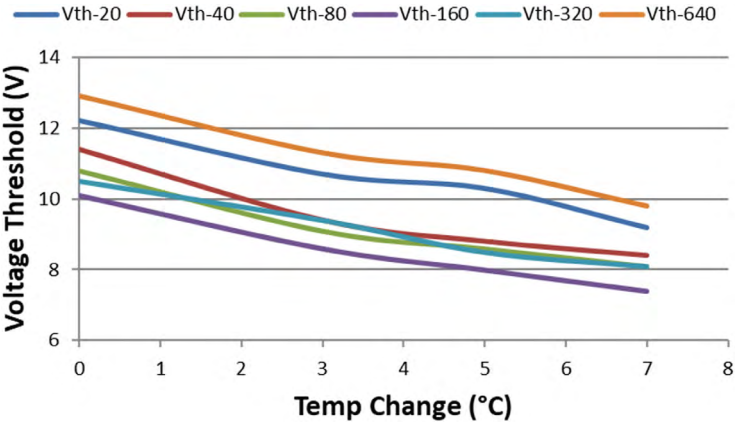


Fig. 3. Average EPT curve of two subjects for electrotactile stimulus of different frequencies (20 Hz, 40 Hz, 80 Hz, 160 Hz, 320 Hz and 640 Hz) at room temperature and at room temperature plus 3 °C, 5 °C and 7 °C.

4 Discussions

In this experiment, EPT was measured in the presence of a background thermal stimulation. The value of ΔEPT_T was observed to be higher 13 to 17% in ETTS. The amount of reduction had been tested statistically using T-test, and it was found significant at all the frequencies. The presence of variability in EPT shows the change in electrical impedance of skin for the individual subjects.

The effect of thermal stimulation had been studied earlier by Larkin et al. [15]. They measured the change in detection threshold of electro-cutaneous stimulus with the application of both heat and cold temperatures. However, they measured thresholds in terms of the total charge, and according to their findings, the total charge doesn't change with heating, whereas it raised with cooling. The current study measured the threshold in terms of the total voltage applied to generate the cutaneous electrical signal on the forearm. It has found a significant decrease in thresholds with heating the skin.

The participants' normal skin temperature varied between 34.5 °C to 36.5 °C, and the pain threshold for human skin is 45 °C. Hence a 7 °C rise was chosen to avoid any pain or burns over the long duration (90 min of the experiment). Any rise in temperature above 7 °C was not comfortable for the users. The pain threshold for the human body is 45 °C [12]. Figure 3 shows results from the rise of three different temperatures (3 °C,

5 °C, and 7 °C). The results suggested that the highest reduction in the threshold was with the 7 °C rise in skin temperature.

5 Conclusion and Future Work

The current study's objective was to develop a method for reducing EPT (for electrotactile displays) in the presence of background thermal stimulation. Reduction in the EPT was found with simultaneous thermal stimulation, which was 7 °C. The study also measured the effect of subthreshold stimuli at multiple frequencies from 20 Hz to 640 Hz in the tuning curve and quantified the EPT reduction at each frequency. A psychophysical experiment was conducted to verify this hypothesis. The results showed a reduction of the electrical stimulus threshold by 15% when used along with a background thermal stimulation.

The limitation of this study is that the skin electrical impedance is not measured during the experiment and is assumed to be constant during the experiment's duration. The slow response of thermal displays is another limitation: higher time is required for the thermal displays to reach the desired temperature. This slower response increases the duration of the experiment as it increases the time taken by the skin temperature to reach normal body temperature before the next trial.

A similar study could be conducted on measuring Vibrotactile Perception Threshold (VPT) [16] with and without BTS, and the findings can be compared. The current study with electrotactile display could be tested with cold stimulus as well. An important aspect in haptic is the haptic illusions. Payal et al. [17] have explained out of body funneling illusion, as a future work we would test the illusion with the background thermal stimulation.

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Physiological Based Adaptive Automation Triggers in Varying Traffic Density

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Abstract. Adaptive automation is paramount in alleviating the undesired effects of high levels of automation. This paper examines various visual physiological measures whilst participants were engaged in conflict detection tasks in an air traffic control environment of varying traffic densities. Results showed that global means of fixation count and duration do not perfectly convey the underlying cognitive processes of operators and that successive comparisons on aircraft targets could serve as potential predictors of conflict detection performance end states. The agnostic nature of successive comparisons to varying traffic densities is also vital in a realistic air traffic control environment where traffic is fluctuating constantly. Additionally, physiological measures derived from such behavioural cues could potentially serve as fail-safe triggers in conventional physiological-based adaptive automation triggers in safety-critical domains.

Keywords: Human factors · Human-systems integration · Systems engineering · Visual physiology · Adaptive automation

1 Introduction

Implementing effective automation tools in process control loops may prove problematic to many stakeholders. One prominent example can be found in the air traffic management (ATM) industry where automation tools are increasingly being leveraged in many ways. From automation assistance in the form of automated warnings in short-term conflict alert systems, which warns controller in time should any two aircraft infringed on the minimum separation distance, to next-generation remote digital towers providing controllers with more information at any point of time than ever. In the pursuit of increased efficiency via the reduction of the operator's workload, more advanced levels of automation are being implemented for any one task. This increasing reliance on automation tools, however, is not a sustainable one.

As higher levels of automation are implemented, the human operator is increasingly distanced from the control loop [1]. Shifting from a controlling role to a more supervisory role, resulting in several implications such as the loss of situational awareness and

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 339–345, 2022.
https://doi.org/10.1007/978-3-030-85540-6_43

emergence of out of the loop (OOTL) phenomena [2], culminating in impaired system performance rather than improving it [3]. Therefore, there lies a need to determine the optimal level of automation for a given task to achieve the desired operation requirements. However, this first requires a need for real-time measurements of operator competency concerning the present task the operator is involved in.

To better design and employ adaptive automation, objective real-time measures can serve as vital feedback loops to machine agents, allowing these machine agents to be aware of when a human agent's performance is to be impaired, resulting in the activation of appropriate automation tools via adaptive automation triggers.

This paper presents preliminary results on an objective and non-intrusive multimodal neuro-physiological trigger approach based on eye movement data and electroencephalography data. Tests were conducted on a series of collision detection trials where participants were evaluated on their ability to detect potential collisions ahead of time. Visual physiological measures were collected in trials of varied traffic densities on a radar display rendering an en-route air traffic control environment.

2 Methodology

Participants (n = 6, aged 23–27) were recruited from a pool of aerospace engineering students at the university. They were required to assume the roles of an executive controller for an air traffic surveillance task. Standard Control Working Position was adopted with a primary radar screen that displays a resolution of 2048 by 2048 pixels with a physical dimension of 50 cm by 50 cm. The primary radar screen was used to display pre-planned air traffic scenarios within the airspace through the use of Netherlands Aerospace Centre ATM Research SIMulator (NARSIM) software. Air traffic information displayed on the screen has a refresh rate of 9.8 s corresponding to a single complete radar revolution.

Along with the radar screen, a Tobii X2–30 eye tracker and Emotiv EPOC + electroencephalography (EEG) headsets were also used to obtain real time physiological data from the participants throughout the experiments. Accuracy and precision of the eye tracker in non-ideal conditions (no chinrest) were found to be 3.5° and 1.1° respectively [4, 5]. Raw visual physiological and radar data were extracted via a post-processing server that had been developed, ensuring temporal synchronicity [6].

Each participant was tasked to complete a total of 3 counterbalanced scenarios of varying traffic density (low: 20–30; medium: 30–40; high: 40–50 planes). In each of these scenarios, 8 unique pairs of aircraft will be flying across the sector with predetermined conflicts at selected waypoints throughout the experimental duration of 20 min. Conflicts in this study were defined as an instance when 2 aircraft infringes the minimum separation distance (5 nm horizontal, 1000 ft vertical) between them resulting in a loss of separation (LOS) as stipulated in ICAO Doc 4444 [7]. The traffic density and pre-planned conflicts were not communicated to the participants to mimic work situations of an ATCO.

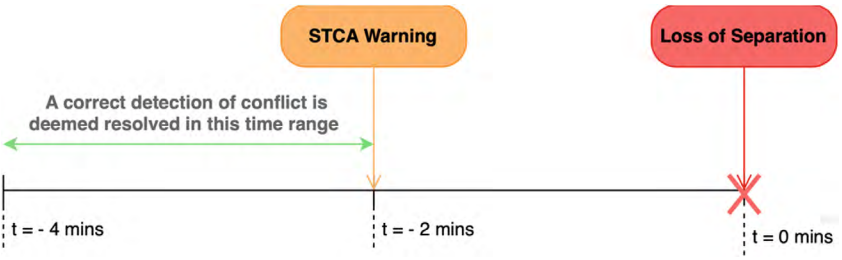


Fig. 1. Conflict detection timeline

Conflict Detection Rate. The conflict identification performance of participants was evaluated based on Fig. 1 above. Determination of conflict pairs before or within that window will be deemed as passed whereas any determination of conflict pairs after or lack thereof will be deemed as failed.

Fixation Count. Fixation counts can be used to evaluate the visual attention and have been found to be tied to underlying processing efforts during target acquisition [8].

Fixation Duration. Similar to fixation counts, the average time represents the relative engagement with the object and its associated cognitive efforts [9].

Successive Comparisons on Target. Successive comparisons are recorded in a hierarchical schema where successive fixations on aircraft targets involved in the conflict are recorded. Successive fixations on the same target will not count.

3 Analysis and Results

3.1 Conflict Detection Rate vs. Traffic Density

Out of 144 conflicts across all 3 scenarios of varying traffic densities, a total of 32 failed instances was observed. A significant increase in failures was observed in medium and high traffic densities. A breakdown of the conflict detection across all 3 scenarios can be found in Table 1.

Table 1. Breakdown of conflict detection rate across varying traffic densities.

Traffic density	N_{pass}	N_{fail}
Low	47	1
Medium	34	14
High	31	17

One-way repeated-measures ANOVA analysis was conducted and showed a significant main effect of traffic density on the conflict identification rate of the participants ($F_{2,10}$= 18.39, $p < 0.05$, $\eta_p{}^2 = .786$). Bonferroni post hoc tests showed that participants performed significantly better in low density condition (mean = .979; SD = .051) than in the medium-density (mean = .708; SD = .171) and high-density condition (mean = .646; SD = .094). However, no significant difference was found at medium and high traffic densities.

The evidence supports the hypothesis that traffic density does affect the participant's ability to timely detect potential conflicts. Furthermore, there seems to be a performance threshold observed at elevated traffic density (medium and high).

Of the 32 failure instances observed, failure mechanisms were attributed to each of them as presented in Table 2 based on the radar visual physiological data obtained [10]. Although a seemingly equal number of failures were attributed to both attention tunnelling (allocation of attention at a particular channel of information for a duration that is longer than optimal) and interface cluttering (overlapping or cluttering of interface elements, rendering apprehension to be more difficult). In many cases where attention tunnelling occurred, attention was in fact diverted to a different cluster of planes and labels elsewhere on the radar screen.

Table 2. Breakdown of failure mechanisms attributed to failed conflict detection in-stances.

Traffic density	Attention tunnelling	Interface cluttering
Low	1	0
Medium	7	7
High	8	9

3.2 Global Visual Physiological Measures

One-way repeated measures ANOVA analysis was completed to investigate the effect of global fixation count and durations in relation to the various scenarios of varying traffic densities. One-way repeated-measures ANOVA for fixation count (($F_{2,10}$= 3.505, $p >$ 0.05, $\eta_p{}^2 = .412$) and fixation duration ($F_{2,10}$= 1.17, $p > 0.05$, $\eta_p{}^2 = .19$) showed no significant main effects between varying traffic densities as summarised in Table 3. This finding is consistent with that existing published works [11].

Table 3. One-way repeated measures ANOVA analysis results across varying traffic densities.

	Traffic density	mean	std dev.	F - statistic	p
Fixation count	Low	1032.833	71.021	3.505	0.07
	Medium	929.667	58.158		
	High	940.500	38.943		
Fixation duration (ms)	Low	870.603	143.152	1.17	0.335
	Medium	924.170	203.489		
	High	956.314	158.617		

One way ANOVA was also conducted on a 1-min analysis window to identify key differences between pass and fail states ($N_{pass} = 112$, $N_{fail} = 32$) for fixation count, fixation duration and successive comparisons on aircrafts involved in a conflict. No significance ($F < 1$) was found amongst fixation counts and fixation durations between the two states (Table 4).

Table 4. One-way ANOVA results for global visual physiological measures.

	State	Mean	Std dev.	p-value
Fixation count	Pass	46.42	11.47	0.825
	Fail	47.05	8.49	
Fixation duration	Pass	22.31	9.66	0.717
	Fail	21.45	6.83	

3.3 Successive Comparisons on Target

Looking at successive comparisons on targets, two-way ANOVA analysis was conducted on successive comparisons across all three scenarios and the pass/fail states, yielding no significant differences across all 3 scenarios ($F_{1,2} = 0.306$, $p = 0.738$), thus retaining the null hypothesis that this measure is agnostic towards traffic densities.

Additionally, one-way ANOVA analysis was completed and significant effects on pass/fail states were observed ($F_{1,4} = 50.68$, $p < 0.001$), indicating that the presence of successive comparisons on targets can serve as a potential indicator for conflict detection (Table 5).

Table 5. Summary of one-way ANOVA analysis of successive comparisons on conflict detection state.

State	Mean	Std dev.	*p*-value
Fail	0.25	0.55	<0.001
Pass	4.40	2.58	

4 Discussion

Based on the results, in comparing the conflict detection rate against the varying traffic densities, a conflict detection performance threshold can be observed in the medium and high densities. This may indicate a potential ceiling effect in cognitive processes as the participants attempt to maintain a coherent mental picture of the situation. Interface cluttering in areas of the sector where a pre-planned conflict is not present may also have potential detrimental effects in diverting attention towards these cluttered areas.

Of the measures evaluated in this paper, global measures of fixation count and fixation duration across the whole scenarios can be found to be unreliable in differentiating the various traffic densities. Finer analysis of each pre-planned conflict also do not reveal much information on the underlying cognitive processes or strategy employed by the subjects attributed to the fluctuating saliency and complex nature of air traffic scenarios [11].

Successive comparisons can be alluded to the participants' conscious act of focusing attention on pairs of aircraft that he/she deemed to be in conflict and can draw parallels to the act of information verification. As ATCOs do not tend to remember individual flight information but rather rely on an abstract mental picture in normal operations, this step is pertinent to the correct identification of potential conflicts ahead of time.

In the context of adaptive automation, by decomposing visual physiological measures and their patterns, measures such as successive comparisons on targets can be a promising indicator of conflict detection states whilst being agnostic to varying traffic densities. These indicators can allow automated resolution aids to be triggered promptly and only rendering aid when necessary, reducing the number of false alarms and unnecessary machine intervention.

5 Conclusion

The results from this study show promise in the utilization of physiological measures for adaptive automation. Conflict detection thresholds were observed in medium and high traffic densities in this experiment. Additionally, the failure modes attributed to attentional tunnelling were also found to also be attributed to interface cluttering elsewhere. This experiment also evaluated the effects of multiple levels of traffic density and found that global measures such as fixation count and fixation duration do not provide much insight into the subjects' cognition in a complex air traffic management environment. Successive comparisons on targets involved in the conflict, however, are positively associated with the timely detection of aircraft conflicts whilst remaining agnostic to the varying traffic densities.

In addition to recent advances in adaptive automation triggers that utilizes electroencephalography as means to detect an operator's mental workload [12], further research is still required in deriving a robust multi-modal physiological model. The incorporation of additional measures will be useful in developing adaptive automation for air traffic radar surveillance that is generalizable, optimal and are able to account for various failure mechanisms that can occur in various complexity levels.

Acknowledgements. This research is supported by the Civil Aviation Authority of Singapore and Nanyang Technological University, Singapore under their collaboration in the Air Traffic Management Research Institute. Any opinions, findings and conclusions or recommendations expressed in this material are those of the author(s) and do not reflect the views of the Civil Aviation Authority of Singapore. The authors would also like to thank all the participants for contributing their time for this experiment.

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Data Collection Using Virtual Reality: Contributions of Human-Centered Design for Research Practices

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Abstract. This article presents research practices for a biometric data collection protocol involving virtual reality equipment, based on principles that guide human-centered design (HCD) and experience design (UX), with the aim of exploring the potential for applying design methodologies and their tools for research practices in data collection in the context of Virtual Reality and others. With the know-how in research and design of the team of the Creativity Laboratory of the Scientific and Technological Park of PUCRS (Tecnopuc Crialab), a research protocol and a participant's journey map were conceived based in the principles of HCD and UX. These were improved based on feedback from tests carried out with researchers and subjects, in an iterative process throughout the research. Based on theoretical contributions and the practical experience described, practices are presented that can be considered in research with virtual reality equipment, and in any type of experiment involving people.

Keywords: Virtual reality · Human-centered design · Research practices · User journey · User experience

1 Introduction

The use of Virtual Reality (VR) has been increasingly widespread for its potential application in areas such as teaching and research [1]. As applications of virtual reality systems expand, new forms of interaction emerge [2]. Thus, discussions about user experience arise in the context of interactions in virtual reality. The discipline of User Experience speaks for all user interaction with a product or service [3], while the discipline of Interaction Design addresses the user experience with technologies, systems and products [4]. Human-centered Design methodologies and approaches (HCD) and its tools help designers to design a person's experience in using a product or service such as User Journey, a tool that helps of creating experiences.

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 346–354, 2022.
https://doi.org/10.1007/978-3-030-85540-6_44

With a multidisciplinary team, Tecnopuc's Creativity Laboratory (Tecnopuc Crialab) develops physical and digital products and services through research and design. Through collaboration, co-creation, and the use of the principles of Human-Centered Design (HCD), behaviors, processes, environments and contexts are investigated. Tecnopuc Crialab operates on the campus of the Pontifical Catholic University of Rio Grande do Sul (PUCRS), at the University's Science and Technology Park (Tecnopuc). This innovative and educational ecosystem promotes interaction, developing innovative projects based on solid knowledge, research and with concrete results in the market.

In partnership with HP Brazil Research and Development Center, Tecnopuc Crialab co-creates meaningful experiences for users using HCD methodologies and its tools in the process of developing hardware and software solutions. Regarding this partnership, this paper's goal is to present the practices adopted by the research team in a data collection protocol using virtual reality, guided by principles of HCD and user experience design (UX). A research protocol serves as an instrument necessary for the development of the activities of an experiment [5], especially when it has the participation of people of different age groups and contexts. In addition to the design methodologies, the design of the participants' journey considered that most of the research participants did not have previous experience nor did know the possible applications of VR. Therefore, the paper explores the potential of applying HCD and UX Design to research practices, aiming to supporting future studies that, unrestricted to the VR and data collection, can be valid for other experiments.

2 Human-Centered Design and Experience Design

The HCD approach prioritizes the human factor in the design process. Its main principle is empathy, which means deeply understanding the reality and needs of the people for whom you are designing for and incorporating their perspective into the creation process. The adoption of empathy in projects is a way to sum to the experience of the design team, the needs of the individuals [6]. In designing new products and services, user participation is understood as essential so that the user can contribute with their vision [7]. In the 2000s, Krippendorff proposed the semantic shift from technology-centered design to human-centered design [8]. Since then, experimenting, prototyping and testing have become the core of the HCD process [6]. The methodology evolved and nowadays HCD is configured as an exploratory, non-linear and iterative process, in which iterations and trial and error from the interactions with users are considered a good practice for generating insights and unexpected discoveries [9].

User-centeredness in the design process has its origin in the term human-computer interaction (HCI) [10], in which the focus of the experience is on the product and the user's interaction with it. From this, a new term is derived in the area of design: User Experience (UX). According to ISO 9241–210, UX can be defined as user's perceptions and responses that result from the use and/or anticipated use of a system, product or service [11]. Nowadays the design of user experiences expands beyond the interaction with computer systems, such as digital experiences [3]. Within the scope of the design tools used in the HCD and UX methodologies, the journey maps offer support in the representation of experiences, as they assist in visualizing processes [6]. User journey

maps are tools that tell a story and are used to understand the user's experience with a product, company or service [12]. In this context, there are also scenarios, narratives of use, usually set in the future, which help to see an experience in an empathic way [12].

3 Virtual Reality

Virtual reality (VR) is a technology that has been around for 25 years. At the time, (VR) technology was considered an extension of 3D graphics with advanced input and output devices [13]. With the advancement of technology, VR has been providing an artificial environment created in software that provide to the user an experience that is faithful to reality [14]. The possibilities for applying VR are wide [15–17], especially if related to research [18]. Some examples of research are in education area, in which the collective use of a virtual environment presents advantages for students in learning concepts related to geometry when compared to traditional learning [19]. Other illustrations of the use of VR applied to research are related to health and well-being. In a study carried out with 30 participants, it was found that the use of VR leads to increased heart rate and motivates children and adults to exercise [20]. In pediatric psychology [21] positive results in reducing the level of anxiety in children using such technology were found. In social studies, a research studied how the body reacts when identifying an uncomfortable posture in the virtual representation of the body [22].

4 Case: Data Collection Research in VR Environment

Technology companies have been continuously working on the development of computing products specifically intended for virtual reality. Initially focusing on the gaming market, this innovation has also attracted the attention of other fields, such as medicine, automobiles, information technology (IT). Based on the desire to further improve products related to virtual reality, it was identified that there is no robust database that links the biometric responses of the user to the cognitive effort spent in VR environments, which makes it difficult to understand the users' overall experience in these environments. Such information can guide the development of better products, more aligned to the real needs of its users. From these premises, and within the scope of the partnership between Tecnopuc Crialab and HP Brazil Research and Development Center, a data collection research project in a VR environment was designed.

From cognitive responses triggered by the performance of users in immersive activities in a virtual reality environment, and their crossing with the data obtained by sensors that monitor low-level physiological systems of those surveyed, high-level insights were be obtained to support the development of algorithms and machine learning techniques, with the objective of improving the users' experiences in existing or new VR associated services and products [23]. The proposition of collecting user's data in immersive environments is innovative, since collections in non-immersive environments generate different physiological, cognitive and emotional stimuli. The collected data in this collaborative research could be used to create models to predict (cognitive) responses to virtual reality experiences. These predictions will be used to optimize the experience of each user individually, in different contexts of product development.

4.1 Data Collection Description

Based on the specificities of the biometric data collection equipment (sensors) associated with the VR equipment (headset and software), it was possible to build a data collection environment that would provide adequate conditions for the experiment. These equipments allow monitoring, controlling and tracking several human activities for a wide field of applications [24]. In the performed research experiment, the equipment used - in addition to a desktop computer - were: (1) VR headset; (2) lighthouses (placed in the corners of the physical space to detect the movements of the headset and controls); (3) hand controls; and (4) biometric data collection equipment.

For the definition of the research sample profile, the population Porto Alegre city, place of study, was considered as a reference [25]. To obtain representativeness of all extracts, both ethnic and age, a proportional distribution was done with a sample of 600 participants. The age range of the sample was 18 to 65 years old, distributed equally between gender and proportionally between ethnicities, without restrictions on educational instruction and social classes, as shown in Table 1 presents the selection and exclusion criteria of the participants.

Table 1. Selection and exclusion criteria

The participant can wear glasses, as long as the model did not have a bifocal (multifocal) lens
Contact lenses can be used during the test
Substantial limitations with visual and auditory skills (disabilities)
Previous negative experience with virtual reality (dizziness or nausea)
The participant must show a document of proof of identity, on the day of the test
No prior knowledge of virtual reality is required for participation

4.2 Research Practices in Data Collection

In the first version of the protocol, three types of tasks were presented randomly in VR several times and at the end of each challenge, there was a question about how much effort was required for that activity. The response rate of an online questionnaire becomes linearly negative according to the size of the instrument [26]. For this reason, in the final version, the number of questions were reduced and only one question was presented for each one of the three types of tasks. Also, the explanation of the functionalities of the equipment was carried out only if requested, to avoid the overload of information in the memory [27]. Regarding the instructions of the tasks to be performed by the participant in the VR environment, the use of printed cards was adopted. This practice is regularly used in validation tests with users in design projects and serves as a visual support for the previous insertion in the tasks to be performed in the test [28]. Such practice proved to be effective in interacting with users.

The equipment needs an adequate physical space for its operation and for participants' mobility. The distance of approximately 1.8 m was defined between the participant's chair and the desk. Respondents must be seated during the collection in the VR environment, so the physical space was configured accordingly. With the participants seated, the quality in the data collected is better, as well as their safety. User comfort should be highly considered when using a VR headset. Because they heat up during use, the room temperature was set between 21 ºC to 23 ºC, as indication [29]. To ensure minimum background noise, silence warning signals on walls was necessary. To clean the equipment used and the environment, at each session the equipment and support furniture were cleaned with the use of alcohol, to avoid possible contamination [30, 31]. Also, the participant's hands were cleaned with alcohol after the test was completed.

The adjustment of the equipment in the participant was done in a way to make them stable for the participant so the data was collected properly. Before the test starts, the participants were guided by the researcher as follows: *Don't feel bad if you can't solve the test challenges. There is no right or wrong, the goal is not to assess your ability to solve tasks, but to understand how you react to the resolution of those tasks.* This information was necessary to keep participants engaged and confident. The participants were asked if he or she was comfortable to continue between some tasks. The characteristics associated with comfort in these cases are adjustment to the body (whether tight or loose), body movements with the product, thermal comfort to avoid sweating, and comfort in use, considering it counts the size and weight in prolonged uses [24]. Since his or her vision and senses are restricted to virtual reality, any action taken with participant during the collection must be done with prior notice.

4.3 Participant's Journey

Using the HCD tool called user journey map, a map was developed describing the research participants' experience from recruiting until the moment they leave the room. This tool was an important visual support for the planning process for researchers. The participant's journey was created based on hypotheses of what the research participant's experience would be like and iterated through the process of applying it. For the recruitment of participants, a specialized company was hired that was responsible for making the first contact and scheduling.

The researcher receiving the participant presents the consent term, a document that describes the research, what data will be collected, and how it will be used, as well as aspects related to confidentiality. After signing the term, the participant is invited to move to the collection station. Another researcher is responsible for conducting the research and describing the test with the support of printed cards. Before accommodating the equipment, the researcher clarifies that possible side effects may occur, such as dizziness, nausea and headaches [32]. Therefore, the participant is told to communicate to the researcher if any symptoms occur, and the test is immediately stopped. This information allows to create mutual trust between the participant and the researcher. Of the 600 collections made, two occurrences of malaise were documented. The data collection process itself has two moments: first, the participant is immersed in a realistic environment. Seated, he is instructed to explore these environments using the hand controls to become familiar with the equipment and the immersive environment. While

the respondent explores the environment, the researcher tests the equipment to ensure that everything is working well. Then, in a second moment, the participant is asked to solve the tests in virtual reality.

After the data collection, the equipment is gently removed from the participant. At this time, participants are asked to share their information about the test and about their feelings and expectations before and after using virtual reality. Subsequently, they are sent to the initial room, where the researcher responsible for the reception also seeks to obtain information about the participant's perceptions related to the test. The attempt to understand the perception of the participants, before and after the experiment, helps to obtain inputs for the due updates and improvements in the protocol that, finally, will support future iterations in the participant's journey. At the end of the participation, a copy of the data use authorization term signed beforehand is delivered, and two tickets to the cinema are given to the participant as a way of thanking them for their participation. The design of the participant's journey process is shown in Fig. 1.

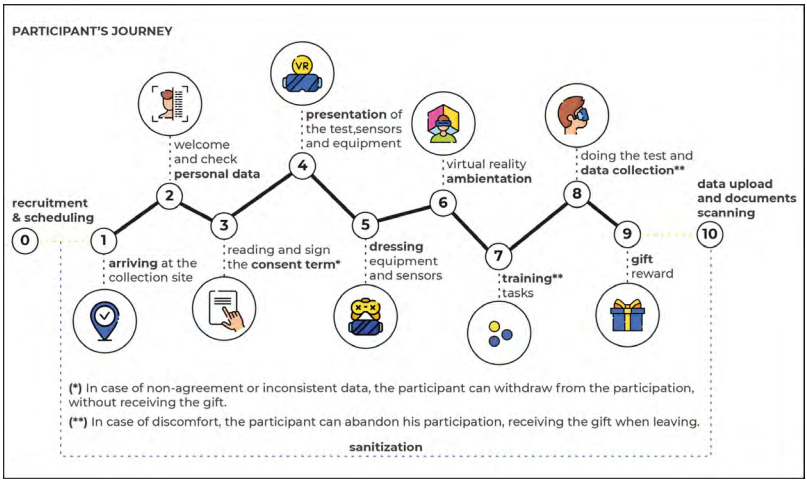


Fig. 1. Participant's journey

5 Discussion

This article sought to discuss the research practices of a biometric data collection protocol involving virtual reality equipment, with the aim of exploring the potential of Human-Centered Design (HCD) and User Experience Design (UX) in research practices for data collection in the context of Virtual Reality. It was possible to improve the research protocol in an iterative and collaborative way, through an empathic perspective, starting from the design of the participant's journey and iterating based on the understanding of their perceptions, behaviours and motivations. Feedbacks were crucial, as they promoted iterations in the process, which made the end journey more suitable for future users [6].

This led the research team to create solutions through a deep connection with users' thoughts and feelings.

The use of design tools to support the planning and collection process, such as printed cards for task instructions and the participants' journey map were essential for the success of the research. Printed cards contributed to researchers' interaction with participants, seeking to reduce discomfort with the unknown, especially for those who had no previous experience with virtual reality. The participant's journey served as visual support for the team of researchers to align, communicate and understand the process of applying the research protocol, as well as maintaining this alignment with the recruiting company, and to promote improvements throughout the collections. It is possible to say that the visual materiality of the tools facilitated communication between all those involved in the research. In this sense, user experience based approaches applied to the planning and conduct of a research with data collection gain meaning. As the participants were the ones submitted to the immersive experience in the virtual environment, the participant's journey became the very foundation for the construction of the research protocol. It was is possible to relate the design of a data collection experience and the HCD and UX processes, regarding the iterativity of the research protocol development. It is believed that this way it is possible to approximate scientific research to the human-centered approach.

6 Final Considerations

A multidisciplinary team of researchers proved to be efficient in identifying and addressing the participants' perceptions in the iterative process of consolidating the research protocol. On the other hand, difficulties were perceived in integrating all the information interpreted by different domains of knowledge, which was circumvented as the research progressed. To offer a safe and pleasant experience, also effective in meeting the research objective (collecting data), it was important for the researcher to observe the participant with empathy, and also important was to offer space for the participant to make considerations about his or her experience. Consequently, this article brings important contributions to the design of more participant-centered research. Based on theoretical contributions, the experience of the researchers involved and the careful observation of collections, it was possible to describe practices that can be considered not only in research with virtual reality equipment and in context, but also in any type of experiment. involving people.

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The Effects of eHMI Failures on Elderly Participants' Assessment of Automated Vehicle Communication Signals

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Abstract. External human-machine interfaces (eHMIs) could enhance the interaction between automated vehicles and surrounding traffic participants if implicit signals are insufficient. Traffic safety requires an appropriate level of trust considering potential eHMI failures. Thus, the current study investigated effects of eHMI system failures on elderly participants' system assessment. During a video-based study, participants assessed an augmented eHMI in three experimental blocks of trials. The first block exclusively displayed valid eHMI signals that acted consistently to the vehicle's movements. The additional blocks also comprised invalid eHMI signals that mismatched the vehicle's movements. Results revealed higher ratings of trust and perceived safety for a valid system acting consistently to vehicle's movements compared to an initial assessment without system experience. After experiencing eHMI failures, participants' system assessment declined. Results underline that eHMI signals are required to be in line with vehicles' movements to support traffic safety and smooth communication with other traffic participants.

Keywords: Automated vehicles · External HMI · Communication cues · System failures · Vulnerable road users · Elderly pedestrians

1 Introduction

Automated vehicles (AVs) offer the potential to support road safety, traffic efficiency and driving comfort [1]. To benefit from the increased automated driving functions and support cooperative and smooth interactions, the requirements of surrounding traffic participants need to be considered by the means of communication in AVs [2]. Communication is particularly required in shared spaces including parking areas, comprising potentially ambiguous encounters due to limited statutory regulations and a diversity of different traffic participants [3]. Thereby, the communication requirements of pedestrians as vulnerable road users should be specifically considered in AVs.

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 355–363, 2022.
https://doi.org/10.1007/978-3-030-85540-6_45

In manual driving, the communication between drivers and surrounding traffic participants is considered as a bidirectional interaction process where the different traffic participants communicate their prospective movements by explicit (e.g., the use of the turn indicator) and implicit signals (e.g., by trajectory) [2]. Different traffic participants mainly rely on implicit communication cues during the interaction with manually driven vehicles [4]. In addition, external Human-Machine Interfaces (eHMI) potentially provide an additional source of information if the conventional implicit communication signals exceed their capabilities [5].

Recent studies reported that participants evaluated eHMI signals for AVs as generally useful [6]. Moreover, participants preferred eHMI signals as an additional communication signal compared to the baseline conditions comprising exclusively implicit signals when interacting with an AV. For instance, participants indicated higher feelings of safety [7] and trust [8] for conditions including eHMI signals compared to the investigated baseline conditions.

However, considering potential eHMI failures (i.e., invalid communication cues between the vehicle's movement and the eHMI signals), an appropriate level of trust in eHMI signals is required if they are applied in AVs to ensure traffic safety. For instance, [9] reported that participants' trust in the eHMI signals declined after experiencing eHMI failures but also recovered fast afterwards. Hence, overtrust in eHMI signals should be considered as a potential safety issue in AVs. Therefore, [10] argued that pedestrians need to be aware of possible eHMI system failures and should still consider implicit driving cues when interacting with a vehicle including an eHMI.

Due to a decline of cognitive, sensory and motor abilities, elderly pedestrians (i.e., pedestrians $\geq$ 65 years) are increasingly imperilled by accidents [11]. To support traffic safety and proactive interactions with AVs, elderly pedestrians' specific requirements should be particularly considered.

Therefore, the recent study investigated the development of elderly participants' trust and reported feeling of safety during repeated interactions with an eHMI in a shared space setting where communication was particularly required. Specifically, valid (i.e., match between vehicle's movements and the eHMI signals) and invalid system functions (i.e., mismatch between vehicle's movements and the eHMI signals) were examined. The current study investigated the following research questions (RQ):

(RQ 1): How do system failures affect the development of elderly participants' assessment of trust during the interaction with an eHMI as a means of communication?

(RQ 2): How do system failures affect the development of elderly participants' reported feeling of safety during the interaction with an eHMI as a means of communication?

2 Method

2.1 Research Design

The present video-based study applied a 3 $\times$ 2 $\times$ 2 within-subject design comprising three experimental blocks of trials, two potential driving maneuvers of the encountering interaction vehicle and two different signals of the augmented eHMI in the vehicle's

windscreen. The study's material displayed a shared space scenario from a pedestrians' perspective. The encountering vehicle either a) initiated a left-turn into an empty parking space resulting in an overlap of the vehicle's and the pedestrian's hypothetical trajectory that would require vehicle's deceleration to give the pedestrian the priority of way to cross the parking space or b) went straight ahead the parking lot without interfering the trajectory of the pedestrian (Fig. 1).

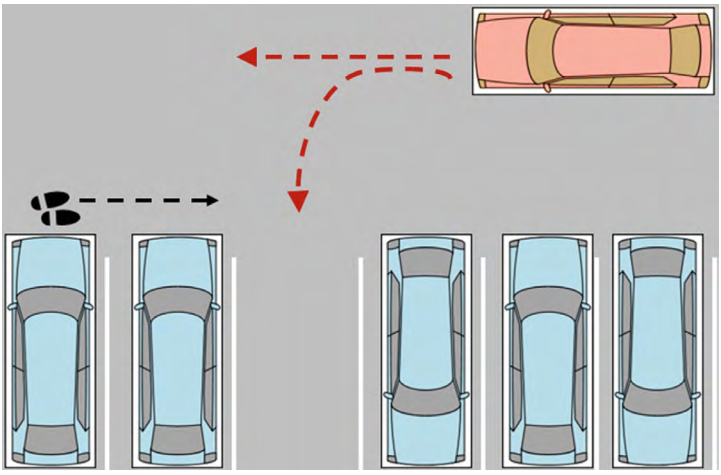


Fig. 1. Recorded scenario of the recent study. The footprints indicate the camera's position that represents the pedestrians' perspective. The red vehicle displays the encountering interaction vehicle including the augmented light-based eHMI with its potential trajectories (i.e., a) driving straight ahead the parking lot or b) turning left into the empty parking space).

Moreover, the augmented light-based eHMI in the windscreen of the encountering interaction vehicle presented two different signals: a) automation mode (indicated that the vehicle was driving autonomously) or b) crossing mode (indicated that the pedestrian could cross the parking space in front of the vehicle). Overall, the participants experienced three blocks of trails, including 18 encounters respectively. The experimental block I exclusively displayed valid system functions implying that the eHMI signals (i.e., explicit signals) acted consistently to the vehicle's movements (i.e., implicit signals). The following two blocks of trials (block II and block III) also comprised invalid system functions, resulting in a mismatch between the communication cues of the vehicle's movements as implicit signals and the explicit communication signals of the eHMI (Table 1). Participants were instructed to evaluate their trust in the eHMI system prior experiencing the system (t_0) and after each block of trials (t_1–t_3). Moreover, participants indicated their perceived safety during the encounter with the vehicle including an eHMI system after each block of trials (t_1–t_3).

Table 1. Overview of the vehicle's movements as implicit communication cues, the eHMI signals as explicit cues and the resulting valid and invalid system functions.

		Vehicle's movements	
		Driving straight ahead	*Left-turn to empty parking space*
eHMI signals	*Automation mode*	Valid system function	Invalid system function
	Crossing mode	Invalid system function	Valid system function

2.2 Material

The study used pre-recorded video material displaying a vehicle's encounter in a shared space scenario. The camera's position intended to indicate a pedestrian's perspective standing in front of an empty parking space (Fig. 1). The videos were recorded by a GARMIN VIRB Ultra 30 (1920 × 1080 pixels, 100 fps). Afterwards, a light-based eHMI was augmented in the windscreen of the encountering interaction vehicle by Adobe After Effects [12]; (Fig. 2).

Questionnaires were applied to collect the development of participants' assessment of the eHMI system regarding trust (t_0–t_3) and reported feeling of safety (t_1–t_3). To assess participants' trust, the 12-item trust scale by [13] was applied. Participants indicated their agreement to the respective items on a 7-point Likert scale ranging from (1) "*not at all*" to (7) "*absolutely*". Afterwards the items were aggregated to an overall trust score (Cronbach's $\alpha = .83$-$.94$). Moreover, participants indicated their feeling of safety by a single item measurement "*I felt safe when interacting with the vehicle*" on a 7-point Likert scale from (1) "*I completely disagree*" to (7) "*I completely agree*".



Fig. 2. Example screenshot of the recorded video material displaying the encountering interaction vehicle from the pedestrians' perspective that is standing in front of an empty parking space and intents to cross this parking space.

2.3 Instruction and Procedure

Since specific requirements of elderly participants were assessed, an age of ≥ 65 years was required to participate in the study. At the beginning, participants were welcomed, informed about the scope of the study and informed consent was obtained. Beyond that, participants filled in a sociodemographic questionnaire. Afterwards, general information about AVs and eHMI signals were provided. The investigated eHMI signals were explained and presented to the participants. A control question had to be answered to ensure for participants' comprehension of the signals' meanings.

Then, participants' initial assessment of the eHMI without any system experience was collected (t_0). After that, block I with 18 trials displaying the encounter of the interaction vehicle exclusively including valid eHMI signals started. Participants evaluated the system afterwards (t_1). Subsequently, block II with further 18 encounters of the interaction vehicle that comprised twelve valid and six invalid eHMI system functions was conducted and was followed by an additional assessment of the system (t_2). In the last part of the study, block III was conducted including further 18 encounters, again with twelve valid and six invalid eHMI signals, and a final evaluation of the system was applied (t_3). In total, the study lasted about 60 min. Participants received 15€ compensation for contributing to the study.

2.4 Participants

In sum, $N = 18$ participants with an age of ≥ 65 years contributed to the study. One participant had to be excluded for further analysis due to answering the control question in the first part of the study incorrectly. The resulting final sample consisted of $n = 17$ participants (7 women, 10 men) with a mean age of $M = 71$ years ($SD = 3.87$; $Min = 65$ years; $Max = 77$ years).

3 Results

The effect of system experience and system failures on participants' assessment of the eHMI was analyzed using repeated measures ANOVAs. Participants' trust ratings of the eHMI and their reported feeling of safety during the interactions with the vehicle served as dependent variables. Since the assumption for sphericity had been violated according to Mauchly's test, Greenhouse-Geisser corrected degrees of freedom are reported for the ANOVA results.

3.1 Trust

To assess the effect of system experience and invalid system functions, participants' trust in the system according to [13] was compared within the study. Trust in the eHMI was collected prior any system experience (t_0), after interacting with a valid system (t_1) and after experiencing invalid system functions (t_2 and t_3). Figure 3 displays the mean and standard deviations for participants' trust ratings across the different measurements. Generally, participants' ratings are over the midpoint of the trust scale for each point

of data collection. The conducted repeated measures ANOVA revealed a significant difference for participants' trust ratings for the different measurements ($F(1.87, 29.87) = 10.34$, $p < .001$, $\eta^2_p = 0.39$). Bonferroni-corrected pairwise comparisons showed that system experience with a valid system had a positive effect on participants' trust in the system compared to the initial measurement without any system experience (t_0- vs. t_1: $p = .002$). After experiencing invalid system functions, participants' trust in the system declined (t_1 vs. t_2: $p = .004$ and t_1 vs. t_3: $p = .006$). There was no difference in trust ratings between the two experimental blocks including invalid trails (t_2 vs. t_3: $p > .05$) and between the initial measurement without system experience and after the experienced system failures (t_0 vs. t_2: $p > .05$ and t_0 vs. t_3: $p > .05$).

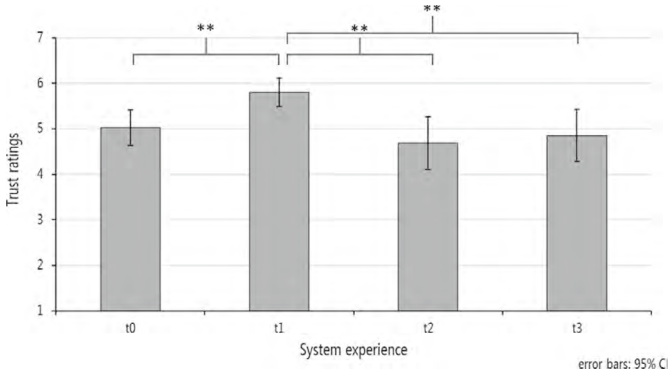


Fig. 3. Participants' trust ratings for the investigated eHMI prior experiencing the system (t0), after experiencing a valid system (t1) and after experiencing invalid system functions (t2 and t3). **p < .01.

3.2 Feeling of Safety

Moreover, the effect of system failures on participants' reported feeling of safety during the interactions with the vehicle was investigated for the different blocks of vehicle encounters (t_1–t_3). Participants' feeling of safety ratings are over the midpoint of the scale for each point of data collection. The repeated measures ANOVA depicted significant differences in participants' feeling of safety across the different measurements ($F(1.40, 22.40) = 18.82$, $p < .001$, $\eta^2_p = 0.54$). During the interactions with the vehicle that included a valid system, participants indicated to feel rather safe (t_1). After experiencing invalid system functions, participants' feeling of safety decreased significantly in contrast to the valid system (t_1 vs. t_2: $p < .001$ and t_1 vs. t_3: $p = .002$; Bonferroni-corrected; Fig. 4). Again, there was no difference in the ratings between the two blocks including invalid trails (t_2 vs. t_3: $p > .05$).

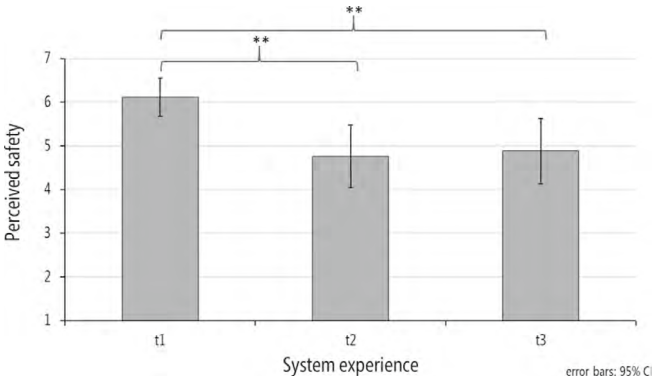


Fig. 4. Participants' reported feeling of safety during the interaction with the vehicle including an eHMI for communication after experiencing a valid system (t1) and after experiencing invalid system functions (t2 and t3). **$p < .01$.

4 Discussion

The presented study aimed at investigating the development of participants' assessment of the system and the effects of invalid eHMI functions as a means of communication in AVs on elderly participants' trust and feeling of safety ratings. Therefore, repeated interactions with a valid (i.e., match between vehicle's movements and the eHMI signals) and an invalid system (i.e., mismatch between vehicle's movements and the eHMI signals) were examined in a shared space setting where communication between different traffic participants is particularly required.

In general, participants rather trusted the eHMI as a means of communication in AVs. The results also showed a positive effect of experience with the eHMI system compared to the initial level of the indicated trust ratings (t_0 vs. t_1), which is in line with previous findings by [8]. After experiencing invalid system functions, participants' trust in the eHMI declined significantly (t_1 vs. t_2 and t_1 vs. t_3; RQ 1), which is similarly reported by [10]. A comparable trend was depicted for participants' reported feeling of safety during the interaction with the vehicle. In detail, participants indicated a decreased feeling of safety during the interactions after experiencing invalid system functions (t_1 vs. t_2 and t_1 vs. t_3; RQ 2). In contrast to previous studies on eHMI failures [9, 10], participants' trust and feeling of safety ratings did not recover immediately after experiencing the eHMI failures within the current study. This could be explained by several invalid system functions in the present study (t_2 and t_3), whereas [9] investigated only a single eHMI failure in their study. However, when examining adaptive cruise control as an automated driving function, [14] could show that omitted system failures resulted in a persistent decrease of participants' trust ratings. These findings could be transferred to the current study, since participants' were not informed about potential invalid system functions of the investigated eHMI.

The effects of experience and system failures of eHMI on participants' system assessment should be further investigated with different age groups, since previous literature depicted a more positive attitude of elderly participants towards automated driving functions compared to younger participants [15]. Moreover, further studies should investigate additional parameters of participants' system assessment with a focus on eHMI failures, such as crossing decisions in closer detail.

Generally, the results of the current study imply that participants considered vehicles' driving behavior as an implicit communication signal in addition to the investigated eHMI signals during the encounters for their system assessment. Therefore, participants seem to be sensitive regarding eHMI failures during the encounter with the vehicle, which is reflected in declined trust and feeling of safety ratings. With regard to traffic safety, it should be highlighted that an appropriate level of trust in eHMIs needs to be calibrated among traffic participants if the systems are applied in AVs. To support smooth and cooperative interactions as well as traffic flow, eHMI signals are required to be in line with vehicles' movements that depict implicit communication signals.

Acknowledgments. The research was funded by the Bundesministerium für Verkehr und digitale Infrastruktur (BMVI, German Federal Ministry of Transport and Digital Infrastructure) – grant no 16AVF2016A; and by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) – Project-ID 416228727 – SFB 1410.

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Unearthing Air Traffic Control Officer Strategies from Simulated Air Traffic Data

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Abstract. With the growth in air traffic volume, automation tools are being developed to increase the capabilities of Air Traffic Control Officers (ATCOs). In this paper, a novel approach to unearth Air Traffic Control (ATC) strategies from raw simulator data is described by utilizing executed radar commands obtained via mouse click data. Five sets of air traffic simulation exercise data were used to identify potential conflicts and unearth likely strategies undertaken using a proposed strategy identification model. The preliminary results demonstrate the success of the model in its ability to identify four distinct strategies adopted by the controllers to safely navigate air traffic conflicts that occurred during the simulation and the conflict type in which they occurred. Strategies identified were also verified by an expert panel to be effective in solving the targeted conflict type. The proposed model can be used to objectively identify ATC strategies for use in automation development.

Keywords: Human factors · Human-systems integration · Systems engineering · Strategy · Automation development

1 Introduction

With an expected increase in global air traffic volume over the long term, the future of Air Traffic Management (ATM) will be heavily influenced by new technological boundaries that will aid in accommodating this growth without compromising traffic safety. Advanced traffic modelling, such as the Four-Dimensional Trajectory Based Operations (4D-TBO), will provide more accurate and consistent predictions of flight trajectories [1]. This would then enhance sector capacity [2] while artificial intelligence (AI) in ATM will be essential in increasing our capabilities to handle both the higher volume of traffic and increasingly complex flows.

The introduction of automation into ATM operations is however not a simple process. Air Traffic Control Officers' (ATCOs) acceptance is one of the key inhibitors towards automation implementation [3] as they are hesitant to accept automation generated solutions without fully understanding the underlying processes that lead to the solution. To improve the controller's acceptance of automated aided decision tools, it was proposed that the automation's problem-solving strategies should match that of human ATCOs

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 364–371, 2022.
https://doi.org/10.1007/978-3-030-85540-6_46

[4]. However, current strategies available in the literature are generic and do not describe the detailed actions required to be taken when handling specific repetitive traffic patterns attributed to a sector's characteristics. Furthermore, these strategies that are often derived from in-depth interviews and questionnaires with controllers [5] are limited as controllers often struggle to substantiate their decisions of the strategy being adopted using strategy-based explanations [6]. To fill this gap and aid in future ATM development, detailed knowledge of ATCO strategies and the traffic situation in which they are effective is essential. As illustrated in Fig. 1, the dotted box area and the strategy identification module in particular, will be the focus of this paper. The identified strategies is fed into the strategy generation module which the AI Decision Maker then uses to select from the best solution to resolve the traffic at hand. For the development and training of automated assisted tools in human-machine teams, knowledge of specific ACTO strategies is necessary to be able to train the automation aids to not only provide accurate solutions to the problem faced, but also solutions that are in line with those of their human ATCO partners.

This paper describes a proposed method used to unearth ATCOs traffic management strategies from raw simulator data and its embedded components. This strategy identification model focuses on deciphering ATCOs strategies for en-route flight clearances as it forms the largest segment of controlled airspace. Failure to manage and adopt the right strategies would lead to traffic accidents/incidents, overloading in the en-route sectors and other parts of the airspace [7]. Flight clearance in this airspace segment is essential to maintain safety separations, achieve optimal climb profile and maximize fuel economy [8]. Utilizing ATCOs radar command executions obtained via mouse click data and radar plots extracted from simulated air traffic exercises, ATCOs patterns of actions and the specific traffic scenario in which it is executed, can be identified. Identified ATCOs pattern of actions were grouped as part of a broader strategy and subsequently analyzed and validated by an expert panel of ATCOs with experience in daily ATM operations. Through this method, four ATCO strategies and the conflict type in which it was utilized in were accurately identified.

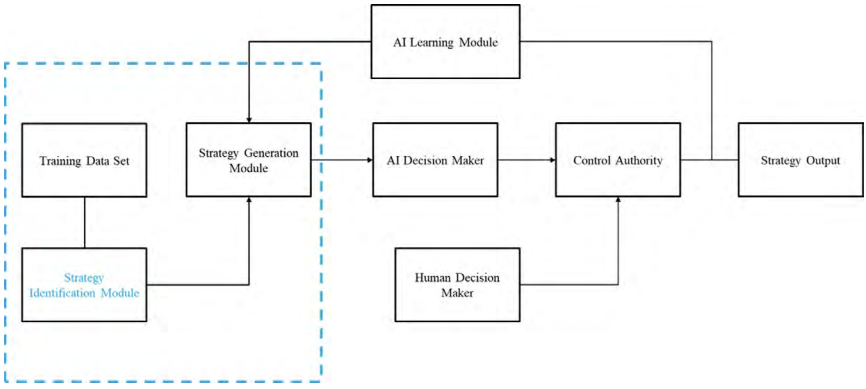


Fig. 1. Illustration of human-machine teams development model

2 Materials Used

2.1 Data Samples

Data sets used in this paper were retrieved from the database of the Air Traffic Management Research Institute in Nanyang Technological University, Singapore. Five sets of data were chosen to be used in this study with each containing ten instances of conflict. As a large majority of the data is obtained from the university student population who do not possess any prior experience with air traffic control (ATC), participants in these experiments are usually given guidance and training before the start of the simulation. Participants are also required to have normal or corrected to normal vision, basic comprehension skills and the ability to communicate in English.

2.2 Experimental Setup

A real-time ATC simulator, Netherlands Aerospace Centre ATM Research SIMulator (NARSIM) Interface, was used in this study. NARSIM is a human in the loop simulator for ATC tower and radar simulations that was developed by the Netherlands Aerospace Centre. The simulator data containing information about the aircraft movement throughout the simulation updates every 9.8 s which matches the amount of time required for one radar revolution in the en-route ATC environment. The simulator data also captures all executive radar commands issued by participants during the length of the simulation via their mouse click activity.

2.3 Experimental Design

The study was designed to unearth flight clearance strategies from data of simulated air traffic conflicts. The simulated traffic data selected thus consisted of ten conflict scenarios belonging to two main conflict types; sequenced climbs, and convergent climbs. Sequenced climbs refer to two or more aircraft climbing one after another along the same airway while convergent climbs refer to two aircraft climbing along adjacent airways that are expected to meet at an angle at a particular waypoint, resulting in an aircraft crossing or an intersection of pathways of the aircraft in question. Conflicts occurred between two to four aircraft at any one point in time. Each dataset contained a 30-min session segment where such conflict types are expected to take place.

2.4 Method

A method to unearth traffic controller's strategies from the simulator data collected will be described below. This method consists of four main stages namely; extraction, event log generation, strategy discovery and strategy verification as illustrated in Fig. 2.

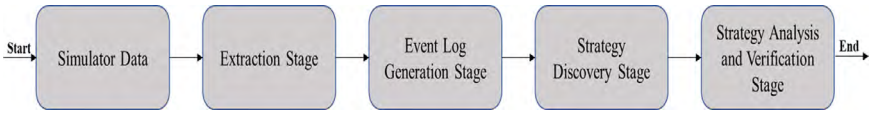


Fig. 2. Illustration of strategy identification model

2.5 Extraction Stage

In this stage, log files were extracted from the NARSIM database in order to study the actions taken by controller participants during the simulation. This raw data consists of various log files broadly organized into information regarding aircraft flight plans, pseudo pilot commands, simulation recordings, aircraft track updates and participant command executions. For the purpose of this study, only the log file containing aircraft track updates and participant command executions was used as it contained all the relevant information regarding the strategies participants used in the simulation.

2.6 Event Log Generation Stage

At this stage, the relevant information is extracted from the raw data file to generate an event log. The event log should contain all relevant information necessary for the subsequent analysis. Python code was written to facilitate the creation of an event log file. The event log file included information on the radar commands executed by participants, together with the associated aircraft callsign, timestamp, speed, and altitude as well as track updates of all aircraft throughout the length of the simulation. The radar commands could range from heading changes, flight level changes and also other commands such as taking/handing over control of aircraft. An example of the event log can be seen in Table 1.

Table 1. Example of event log generated for analysis

Time/Min	Callsign	Latitude	Longitude	Speed (knots)	Altitude	EFL
0:09	S001N892	3.895717	105.7343	170.73509	201.1822	0
0:09	C006N884	2.826538	105.0113	162.32226	300.847	0
0:09	C006N884	2.826538	105.0113	162.32226	300.847	0
0:19	S001N892	3.886096	105.7222	176.83274	202.856	220
0:19	C006N884	2.831739	105.025	166.25097	301.9201	0

2.7 Strategy Discovery Stage

During this stage, possible strategies used by participants to resolve air traffic conflict were identified. To better understand why a particular command was executed by participants during the stimulation, a snapshot of the environment in which the command was

issued can be recreated using the timestamp at which the command was given. From the track updates in the event log file, the latitude (x-axis), longitude (y-axis) and altitude (z-axis) of all aircraft at the time of the executed command, as well as their associated speed and bearing, can be extracted and plotted out. In this way, not only can the corresponding aircraft in the conflict be easily identified but the exact conflict type can also be accurately determined. Furthermore, details regarding other aircraft in the immediate vicinity or even any aircraft that was present at that moment in time can also be included as part of the later analysis if required as the data is readily available in the event log file.

As reported by Rantanen and Wickens [9], conflict type can easily be categorized by the geometries in which they occur in, be it horizontal, vertical or both. Horizontal geometries can be broken into three categories, same, crossing, or opposite, depending on the conflict angle being less than 45°, within 45 to 135° or more than 135°. The conflict angle can be calculated using Eq. 1 as the angle between the slopes of the two aircraft in conflict.

$$AOC = \arctan\left|\frac{m_1 - m_2}{I - m_1 m_2}\right| \tag{1}$$

Vertical geometries can similarly be classified into parallel climb/descents, vertically converging or when both aircraft are at the same level. This classification can be done manually or automatically with a use of a conflict detection tool. Such tools can aid to efficiently identify and classify the conflict type. In this study, all simulated conflict falls within two categories, crossing-parallel and same-parallel as all aircraft are executing parallel climbs prior to any intervention from the participants.

Once the conflict pair and type has been established, the subsequent executed radar commands issued between the two aircraft up till the point at which both aircraft have safely reached their desired altitude can then be extracted. These are then grouped together as part of a broader strategy adopted by the participant. To better understand how each executed radar command is related to the other, details of the conflicting pair and even other aircraft in the vicinity can be continuously extracted and plotted out according to the timestamp at which the command was issued. In this study, the control strategy was limited to flight level changes, however, for future studies, strategy for adopting the preferred heading or speed changes can also be extracted and analyzed.

2.8 Strategy Analysis and Verification Stage

In this stage, the identified strategies are analyzed with reference to a set of performance indicators such as efficiency, robustness, fairness, safety, or equity [10] and are subsequently validated by an expert panel of ATCOs with experience in daily ATM operations.

3 Results and Discussion

From the data sample, 30 of the 50 conflict pairs were safely managed. As mentioned above, safe management of the conflict is determined by successfully climbing the aircraft pairs to their desired altitude without any safety infringements which in this case,

is a loss of separation between aircraft. The remaining 20 conflict pairs were excluded from analysis as they were either not able to climb aircraft to their desired altitude or failed to do so safely. The conflict types in which the 30 conflict pairs occurred were also identified and classified into two categories, crossing-parallel and same-parallel based on the geometries of the conflict. From the 30 conflict pairs that were successfully managed and their associated strategy, four distinct sets of strategies were identified and grouped according to conflict type. Two strategies were identified each for the crossing-parallel and same-parallel conflict types as tabulated in Table 2.

Comparing between strategies utilized in the same-parallel conflict type, S1 represents a more efficient strategy as both aircraft reach their desired flight level the fastest and the succeeding aircraft, which is required to climb to a higher altitude can climb unimpeded, thereby reducing any fuel costs due to a staggered climb profile. However, compared to S2, S1 loses out in terms of equity as the preceding aircraft, which should be given priority by virtue of being first, had to maintain a lower and less fuel-efficient altitude for a longer period of time to allow for the succeeding aircraft to outclimb it.

Strategies identified in the crossing-parallel conflict type on the other hand were both equally equitable as the higher aircraft was always given priority and allowed to climb unimpeded. They did however differ in terms of efficiency. C2 allowed for the lower aircraft to continually climb for longer as compared to C1 which resulted in a more fuel-efficient climb profile. The lower aircraft in C1 however was allowed to climb to the next flight level only after the higher aircraft had cleared that level or otherwise known as a stepped climb. This resulted in a less optimal climb profile. It is worth noting that C2 required more monitoring from the controller to stop the climb of the lower aircraft at an appropriate time. This strategy would understandably run a higher risk of errors during situations of higher traffic intensity or complexity as the controller could very easily lapse in their monitoring, resulting in a loss of separation.

While similar strategies have been reported by Erzberger [11], the identified strategies were also validated in terms of relevance and accuracy by an expert panel of ATCOs with a combined experience of over more than 15 years of ATC experience in en-route operations. The panel was able to identify the four strategies from a list of eight that contained an additional four dummy strategies, thereby verifying that the individual steps when put together do form a broader strategy that can be used to resolve conflict. Furthermore, when given all four strategies and tasked to match them to either of the two conflict types, the panel was also able to correctly match them with the conflict type in which they could be used to resolve.

Table 2. Summary of identified strategies classified by conflict type

Conflict type	Breakdown of strategy
Same-Parallel	S1a: Stop climb preceding aircraft while succeeding aircraft continues climb S1b: Once succeeding aircraft is higher, step climb preceding aircraft till desired altitude

(*continued*)

Table 2. (*continued*)

Conflict type	Breakdown of strategy
	S2a: Stop climb succeeding aircraft while preceding aircraft continues climb S2b: Once sufficient lateral separation is achieved, climb succeeding aircraft to desired altitude
Crossing-Parallel	C1a: Step climb aircraft at lower altitude C1b: Once clear of intersection point, climb aircraft to desired altitude
	C2a: Climb aircraft at lower altitude to intermediate altitude C2b: Stop climb lower aircraft at safe altitude when nearing the intersection point C2c: Once clear of intersection point, climb aircraft to desired altitude

Overall, the proposed strategy identification model presents a new method to identify strategy used in ATC. Strategies identified can then be analyzed and compared against one another to determine the most effective strategy for every situation. This overcomes the need to interview ATCOs in order to decipher the thought processes that underlie their decisions during operational work. Furthermore, as each sector has its own unique characteristics and peculiarities, this model can be used to unearth various ATCO strategies used in each specific sector without disruption to the operational work of the ATCOs. These identified strategies can then be used in multiple ways. A personalized automation tool could be developed that alters its suggestions to match the style of the ATCO working thereby increasing automation acceptance and preventing the infamous out of the loop phenomenon. These strategies could also be used as training aids to improve ATCO skills and optimize their current set of strategies.

It is also worth noting the inherent limitations of model. While useful for identification of strategies used in en-route operations, it is not as effective when applied to data from aerodrome and approach control as both these cases are more dynamic and uncertain as this involves aircraft that have yet to leave the ground and thus do not yet appear on the radar. Thus, other information sources would need to be fed into the model for it to work as proposed. Second, since the model was designed for the identification of strategy, it does not work if no interventive actions were taken.

4 Conclusion

In this study, a new method of strategy identification was proposed to unearth strategies that were used by participants in a simulated ATC environment from raw data. Executed radar commands for flight level changes made by participants via mouse clicks were collected for this purpose. The results showed that the proposed approach was effective in identifying participant strategies and the conflict type in which it was used within. Furthermore, these strategies were subsequently validated by an expert panel for relevance and accuracy. The proposed strategy identification model has various implications on the development of automation tools for use in ATC. The future development

of this research will be focused on looking into identifying strategy that utilizes other techniques beyond that of flight level changes such as changes in heading and speed.

Acknowledgments. This project is supported by the Civil Aviation Authority of Singapore and Nanyang Technological University, Singapore under their collaboration in the Air Traffic Management Research Institute. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not reflect the views of the Civil Aviation Authority of Singapore. The authors would also like to thank all the participants for their valuable time.

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Environmental and Ergonomic Considerations for Augmented Reality User Experiences in Vehicle Diagnostics Tools

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Abstract. The advent of augmented reality technology has been a boon for automotive segment, particularly the vehicle diagnostics. Augmented reality enables the overlay of critical diagnostic digital data on the field of view of the real-world vehicle parts thus providing valuable information with the context of diagnosis and repair thus greatly reducing the digital-analog divide. Another key advantage in augmenting critical information like DTC codes, RT measurements over the actual vehicle parts helps in reducing the cognitive load for the technician in remembering the details from service manuals and can help in lowering the human error factor as well. This is one of the reasons why many of the tier 1 vehicle OEMs are eagerly embracing this technology. However, the platform on which most of the tools are designed are predominantly smartphone and tablet based since the smartphone hardware and software provide a cost effective as well as comprehensive ecosystem for rendering the augmented content. This, in reality, poses challenges from an environmental and ergonomic standpoint for the technician who needs to use these tools in conditions which is dynamic and may not always be linear. The paper details study ongoing across multiple geographies including US, Europe and India involving contextual observations as well as moderated in person interviews conducted with the technicians with an aim to capture the environmental conditions and ergonomic factors pertaining to the technicians' work zone and how it influences the user experience of designing augmented reality tools for vehicle diagnostics. For the purpose of this study, application of readily available and cost-effective AR platforms is being considered and high-end mixed reality headsets like Microsoft's Hololens are excluded.

Keywords: Augmented reality · Vehicle diagnostics tools · Environment · Ergonomics · Smartphone · User research

1 Introduction

Augmented Reality has been gaining prominence in the recent few years. From its beginnings as experiment in head mounted display in 1968 [1], the technology has gained increased traction, particularly, as smartphones have become powerful and camera

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 372–377, 2022.
https://doi.org/10.1007/978-3-030-85540-6_48

technology accurate enough to render high quality digital data augmented over real-world view and in real time. One of the myriad domains where Augmented Reality (AR) can be very helpful is in the field of automotive diagnostics.

The global Automotive Diagnostics Market is forecasted to grow at a rate of 4.4% from USD 39.75 billion in 2019 to USD 56.0 billion in 2027 [2]. With the increased proliferation of cloud technology, increased ECU capacity in vehicles to the evolution of AI and autonomous driving technology, vehicle diagnostics has become critical for the automotive segment. North America leads this pack with projected growth of CAGR 4.8%.

Despite this growth in the diagnostics market segment, the scenario for diagnostics technicians is on the decline. Bureau of Labor Statistics (BLS) projects 4% decline in the job outlook towards 2029 [3]. This is partly attributed to the increase in sensors, implementation of AI and predictive maintenance and instrumentation which will reduce the maintenance complexity and thus reduce the need to more manpower. However, many of the electromechanical tasks including replacements and repairs will still need human intervention thus necessitating the need for skilled technicians. It is projected that there will be an need to fill atleast 46,000 roles through 2026 [4]. Novice technicians are more tech savvy as opposed to expert technicians. This presents an exciting opportunity to inject innovative technical solutions to help improve the efficiency of diagnostics, reduce the friction during test and repair procedures and ultimately contribute to lowering the human error quotient in vehicle diagnostics and repair.

One of the technologies which is very well suited for this domain is augmented reality. By its inherent nature vehicle diagnostics relies on the amalgamation of real time data from the multitude of sensors and instrumentation in the vehicles with service manuals and user identifies symptoms to help test and ultimately diagnose the issues. Traditionally expert technicians use digital tools to read the diagnostics data and combine that with perusing the service manuals or through experience recall the possible causes that could contribute to an issue. Many of them having worked decades are able to intuitively diagnose vehicles. However, as more and more newcomers are recruited into the industry coupled with the retirement of expert technicians and the rapidly evolving technology landscape in the automotive manufacturing, being able to leverage innovative technical solutions to reduce the cognitive load on the novice and sometimes even experienced technicians will be of advantage.

AR can be poised to provide a best of both worlds solution by augmenting the digital data from vehicles and service manuals over the electromechanical elements of the vehicle thus enabling newer use cases for diagnostics and repair. Furthermore, the proliferation of low cost but technically capable smartphones which have AR frameworks built into them can really help make this technology a mainstream aspect of vehicle diagnostics domain. But, from the perspective of the technician this introduces an additional artifact into their workflow, a tool which can have implications from the standpoint of ergonomics of how they can use the same as well as how the environment in which they operate can impact the efficacy of the technology. This paper is an ongoing study to understand the above-mentioned implications of AR in the real-world applications for vehicle diagnostics.

2 Method

The study has been conducted so far with about 15 participants. First mode of study involved a contextual observation to understand the behavioral aspects of the technicians work in their natural environment. The observations focused on the ergonomics as well as the dynamics of how the environment changed during a typical work session and how the technicians reacted to the same. This was further followed up with in person interviews with a select group of technicians categorized on their experience as well as the type of work they do. Few of the elements being studied include ergonomic like interaction behaviors, use of tools including one handed and two-handed usages, accessibility and environmental elements like light, sound, working space etc.

3 Observations

Many of the technicians use multiple tools to diagnose and repair issues. While experienced technicians are proficient to run multiple steps of diagnostics in one go, novice technicians sometimes perform tests in smaller steps. Novice technicians, in particular, rely on the service manuals as well as instructions to perform the diagnosis. Furthermore, by nature age, they have increased affinity to technology and are very comfortable using smartphones and tablets while the more experienced technicians rely less on the manuals and are more accustomed to traditional tools. However, the increasing complexity of the vehicle technology requires knowledge and use of advanced toolchains. One of the points unearthed during the study was that the disconnect between the digital tools which are usually on a shared laptop and the mechanical nature of the work which needs to be performed on the vehicles leads to frequent switching between the two activities leading to longer time and lesser working efficiency. Even mobile and handheld tools require them to switch their view from working on the vehicle to reading data on a screen and then correlating with the hardware (e.g., wiring diagrams) which leads to increased cognitive load. Leveraging AR based tools which can display the digital information like the wiring diagram on the actual hardware thus simplifying the effort needed. While this is certainly beneficial, there are still a few areas that need to be focused from environmental and ergonomic standpoint.

3.1 Lighting

Based on the observations during the study it is apparent that the lighting is better over the hood and in most work areas but can be limited under the hood. There are some hard-to-reach areas which are obscured by foreground elements of the vehicles like base plates etc. Technicians use torches to view the area which by itself presents ergonomic constraints. In some instances, they use torch with a headband that can be work around the head and thus free up both hands to work.

However, for AR tools on mobile devices, the built-in camera flash can be used to illuminate the area and as well provide visibility to the digital content on the screen. But bad or improper lighting can cause issues with properly rendering AR content on the screen as the software may not be able to identify the areas and boundaries properly. Ergonomically, this still requires one handed usage which can be a limiting factor in some situations.

3.2 Noise

Most of the work areas are usually noisy, with extreme noise requiring use of headphones. While noise itself isn't a detracting factor for the use of AR tools on mobile devices, it still presents challenges integrating voice prompts in the user interface or to use voice commands for interacting with the content. Voice interactions can be beneficial for technicians as they would be able to navigate some of the content on the app handsfree but in high noise situations this will be challenging.

3.3 Dexterity

Most of the technicians, both novice and expert, mention that they frequently need to use both hands to perform tasks during repairs. During diagnosis, they can manage with one hand, if they are using handheld tools, but with many traditional desktop tools they would need to move between the vehicle and the workstation to read the data and work on the problems. Using AR tools to display the diagnostic data during the diagnostics phase will be easier even with one hand while they may need to place the device away when performing repairs. In order to improve the user experience by reducing the need to repeatedly render the data each time the technician needs to use the device, it would be useful to provide an option to freeze the data on the screen with the rendered instructions and data so that the technician can put the device away and then pick up where they left off with the screen displaying all the relevant data again to during the diagnosis and repair time. This will also have the added advantage of reducing processing power and saving battery while helping technicians use the tool more efficiently.

3.4 Spatial Constraints

One of the observations related to space constraints for technicians is related to under the hood work where the space and motion can be restrictive. This can present ergonomic challenges for using AR tools as they would need to hold the device still to be able to get the digital content rendered as sudden movement of camera coupled with reduced lighting [5] can affect the simultaneous localization and mapping leading to improper rendering of the AR content or erroneous situations where the tool may fail. To enable technicians to better work in limited space, the user experience should enable graceful recovery in case of error and display instructions to help the user hold the device and position better and so on.

3.5 Screen Interactions

Touch screen interactions are difficult since technicians wear gloves and also the hands can be greasy/dirty which will impact the efficacy of the touch interactions. Keeping interactions minimal is pertinent to ensure good user experience. The device can be designed to react to different changes in view and to intelligently display the data. Use of one or two large touch zones for all interactions so that the touch need not be precise is also recommended.

3.6 Accessibility

Senior technicians in particular face accessibility issues when viewing the smartphone displays. In AR tools the augmentation of the digital data on the analog view on the camera behind is sometimes harder for them to view due to irregular colors, contrast etc. One solution is to use very high contrast and non-natural colors to render the view so that irrespective of the background imagery, the data is clear. Additionally, providing option to temporarily blur the background is also helpful to put focus on the content. Additionally, ability to change font size and density as well as micro interactions on the screen to help draw attention to the crucial elements also enhance the usability. Despite all this, some senior technicians who have visual challenges might find it harder to use AR tools.

3.7 Head Mounted Displays

While this study did not consider head mounted displays (HMD) due to the fact that they are either expensive and difficult to use for prolonged periods or still in development stages, some of the observations from this study can be extrapolated to HMDs as well. While HMDs have an advantage in ergonomics due to the fact that technicians can use both hands and still have access to the AR tool, the field of view in most HMDs are limited and the ability to render and interact with digital content is also difficult. Due to higher noise in the work areas, using voice commands is also difficult. From a usability standpoint, HMDs would need to be comfortable to wear and also be light weight. They should have higher resolution displays capable of displaying rich media content and support powered lenses as many senior technicians have that requirement. Furthermore, they should have ability to illuminate the field of view similar to using the flashlight in the mobile AR app to be able to work in low light areas. Future advancements in technology might lead to smaller footprint SOCs and better battery that help in designing an HMD which can provide for the above user experience considerations.

4 Conclusion

Augmented Reality tools on mobile platforms can be of huge help to technicians over the standards desktop and handheld tools as they reduce the cognitive load of data association and identification during the vehicle diagnostics and repair process. Many of the technicians, however, are not sure about how these tools will be of advantage since these are not prevalent yet. The focus of this study was to identify the environmental and ergonomics considerations for these tools to be usable to technicians. Further study will focus on evaluating these considerations through usability studies through mock participatory sessions and also identifying scenarios where these tools can have maximum efficiency and conversely the scenarios where these tools may not be useful. One point that seems to be clear is that as vehicle technology increases at exponential rates, the diagnostics tools as well as the technicians need to also match pace to manage the maintenance of such vehicle. Well-designed AR tools with these considerations taken into account will help technicians in this regard.

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Development of a Holistic Care Platform - A User-Centered Approach

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Abstract. This paper presents the first results of the development of a holistic care platform. A user-centered approach is taken to align the platform as closely as possible to the needs of potential users and to create real added value with the platform in contrast to existing solutions. In the context of this study, the term user is understood to mean both people with assistance needs and their relatives or caregivers, but also potential providers who offer their products or services via the platform. Within the framework of the user-centered approach, potential competitors were first analyzed. Besides, a qualitative analysis was conducted to identify unmet needs and implementation ideas of the users that could be covered by a care platform.

Keywords: User-centered approach · Care platform · Qualitative analysis · Expert interviews

1 Introduction

In the course of demographic change and the shortage of skilled nursing staff prevailing in many countries, solution concepts are needed to efficiently distribute the limited resources in the health and care sector [1].

Current studies indicate that an extension of outpatient care in one's own home is not only preferred by a large part of the elderly [2] but could also be achieved compared to inpatient accommodation with considerable cost savings for long-term care insurance funds, municipalities, and - with appropriate apportionment procedures - also for those in need of care and their relatives themselves [3]. To enable holistic care in one's own home, a network of different service providers is usually required. This can consist of family members, neighbors, volunteers, but also, for example, professional care providers and service providers for low-threshold services. Besides, depending on the type of assistance required, it can make sense to use technical assistance systems such as fall sensors, reminder functions, voice assistants, etc.

The results were produced as part of the interdisciplinary research project Smart Care Service funded by the EU and the state of North Rhine-Westphalia (EFRE.NRW). A holistic care platform is to be developed as part of the research project. With the help of the platform, bottlenecks in nursing staff are to be minimized through the efficient

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 378–385, 2022.
https://doi.org/10.1007/978-3-030-85540-6_49

use of resources. A platform solution is being developed that brings people in need of care together with available providers in their vicinity in a timely and flexible manner.

The platform is intended to offer added value both for people with a need for care and assistance services and their relatives and for the providers who offer their products and services via the platform. In the area of professional care, the platform is intended to help relieve the burden on care staff so that they can focus more on the interpersonal, social aspects of care.

So far, there are already a large number of care platforms on the market that pursue a similar goal. However, despite the high potential assessment for a holistic care platform, no solution has yet been able to establish itself on the market. One problem here is the lack of suitable business model structures. This includes, for example, the development of financing models through which the platform can sustainably exist on the market even after a funding phase. For financing models to be effective, the platform must offer added value for the actors on the platform so that they are willing to pay money for it.

Previous research projects have shown that early involvement of the potential target groups can have a decisive influence on the development result and the acceptance of the target groups [4]. Therefore, within the framework of the project presented here, a user-centered approach should be aimed at from the very beginning to develop a platform that can cover existing needs on the part of providers and persons with assistance needs as well as their relatives and thus create added value on both sides.

In a first step, it will therefore be investigated which topics are already well implemented via existing care platforms. Also, it will be analyzed how a holistic care platform would have to be designed from the perspective of providers and users and which needs currently still exist on the provider and demand side that could be covered by a care platform.

2 Method

In this chapter, the user-centered approach followed for the development of the care platform is presented first. This is followed by a methodological introduction to the competitor analysis and the qualitative analysis.

2.1 User-Centered Approach

There are many design methods and approaches that can be used in the field to properly combine user requirements with technical constraints and capabilities. One of them is *User-Centered Design*. This approach is particularly used in projects that require a high level of usability to be successful. It allows a product to be designed with unique features that affect the usability performance of products used by the majority of the population [5]. The user-centered design approach focuses on shifting away from a reactive approach, where environments, furniture, and equipment that cause problems and disruptions are changed after something unpleasant happens, to a proactive approach that aims to design and improve each element based on the targeted needs of a specific category of users. The aim is to gain a deep understanding of the groups of people who will use the product or service. Interactively and based on the needs and requirements of

the future users, a product or service should be developed that creates real added value [6].

The process of user-centered design encompasses the entire development life cycle of a product or service. The international usability standard [7] provides information on how a user-centered approach can be designed (see Fig. 1).

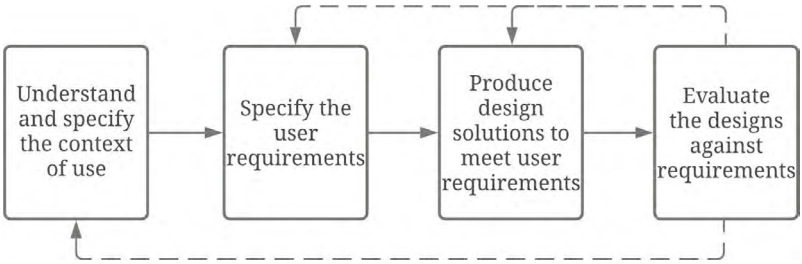


Fig. 1. Process of the user-centered approach (following [7])

The process can be divided into four phases, whereby the design of the individual phases should be adapted to the context of use. In the first step, the context of use is analyzed. In this phase, information about the potential users is collected and needs are identified. Also, the environment is analyzed. Methodically, competitors and target groups could be analyzed, personas developed and potential users interviewed in this phase, for example. In the second phase, requirements for the product or service to be developed are defined. This is followed by the development of a first draft and a concept. This can take the form of design documents, a mock-up, or a prototype. This is followed by an evaluation of the developed concept and design. This involves checking the extent to which the identified requirements have been implemented. This usually involves talking to potential users again, trying out the mock-ups and prototypes, and interactively adapting the concept accordingly [6, 7].

Against the background of the research object presented, possible competitors were identified and analyzed in a first step. In the next step, initial target groups were analyzed. Subsequently, expert interviews were conducted to obtain input from people from various fields and to define requirements. In the third phase, use cases for a care platform were developed. On this basis, a mock-up is now being developed, which will then be evaluated before a prototype is developed. In the following, the results of the competitor analysis and the survey of potential users are presented. In the context of the research object considered here, not only the typical users of the care platform, i.e. persons with assistance needs and their relatives and caregivers, should be the focus of the analysis, but also potential providers who offer their products or services via the platform.

2.2 Competitor Analysis

For the platform to be developed to distinguish itself from existing providers and to offer real added value for both the providers of care or household-related services and the users

of the platform, a competitor analysis was carried out in a first step and a survey of potential providers and consumers in a second step. For the analysis of existing care platforms and thus potential competitors, a benchmark analysis was conducted following Fleisher and Bensoussan [8]. For this purpose, six categories or topic areas to be investigated were initially defined. The focus was on the portals' offers, quality aspects as well as marketing and financing measures. For a more detailed analysis and characterization of the individual categories, suitable criteria for comparing the individual platforms were then defined. The defined categories and criteria were then used to examine twelve care platforms, which were selected based on the estimated level of popularity among the platforms in Germany.

The selected care portals are mostly platforms that are still quite young. Most of the platforms were founded between 2010 and 2015. The required data on the individual platforms was collected in a first step on the platform itself by looking at and reviewing the listed offer from the customer's perspective. Furthermore, in a second step, press articles on the platforms were reviewed and the social media presence was examined [16].

2.3 Qualitative Expert Interviews

To find out what concrete wishes people in need of help and their relatives on the one hand and providers of products and services on the other hand have and how their lives could be improved with the help of a care platform, qualitative guideline-based expert interviews were conducted in 2020. The external survey aimed to identify the needs and implementation ideas for a care platform on the provider and demand side. In contrast to standardized interviews, guided interviews are characterized by more openness. This should contribute to an unbiased approach towards the interview partners so that they are encouraged to describe their respective perspectives [9]. In the field of qualitative social research, a differentiation is made between a variety of guided interviews, which, however, all use the guide as a data collection instrument. In the field of guideline-based interview methods, the expert interview was selected as a suitable method against the background of pursuing the research interest. In the context of expert interviews, the focus is not on the experts, as is usual in most types of interviews, but rather the interviewees stand as representatives for their field of action or topic [10].

The interview guideline was compiled and structured according to the SPSS principle of guideline compilation by Helfferich [11]. SPSS stands for the parameters "collecting", "checking", "sorting" and "sub-summing" [12]. This method was used to guarantee a certain openness on the one hand, but on the other hand to ensure a rough framework for conducting the interview. Therefore, numerous questions and keywords were first collected in an open exchange. In a second step, these were reviewed and, if not suitable, removed from the collection or put on hold. The remaining questions were then sorted according to content aspects and integrated into the common formulation requirements of qualitative interview guidelines. By this is meant that the questions were formulated as openly as possible, generally comprehensible and narrative-generating, to achieve the greatest possible gain in information. Finally, the guide, consisting of 8 categories and a total of 32 questions, was put into its final form [13]. When selecting the sample, care was taken to ensure that the heterogeneity of the research field was reflected as

much as possible [14]. Due to the limited time frame for the research project, theoretical sampling was dispensed with, and instead, selective sampling was carried out. In selective sampling, criteria are defined in advance based on which the interview partners are to be selected. In the context of this analysis, the experts interviewed should come from as diverse a range of fields as possible and be currently in regular contact with potential users of a care platform or potentially interested in appearing as a provider on a care platform.

The interviews were mainly conducted face-to-face and documented using a dictaphone. All experts agreed to the recording of the interview and therefore signed the privacy statement prepared for this purpose. A total of 15 experts were interviewed in 2020. The length of the interviews varied between 45 and 90 min. The following figure shows the different areas of the groups that were interviewed. People from the field of care services were interviewed, as well as people from care and social counseling services, health and care insurance companies, housing counseling services, voluntary organizations, financial service providers, senior citizens' representatives, and from the field of mail-order pharmacies [16, 17] (Fig. 2).

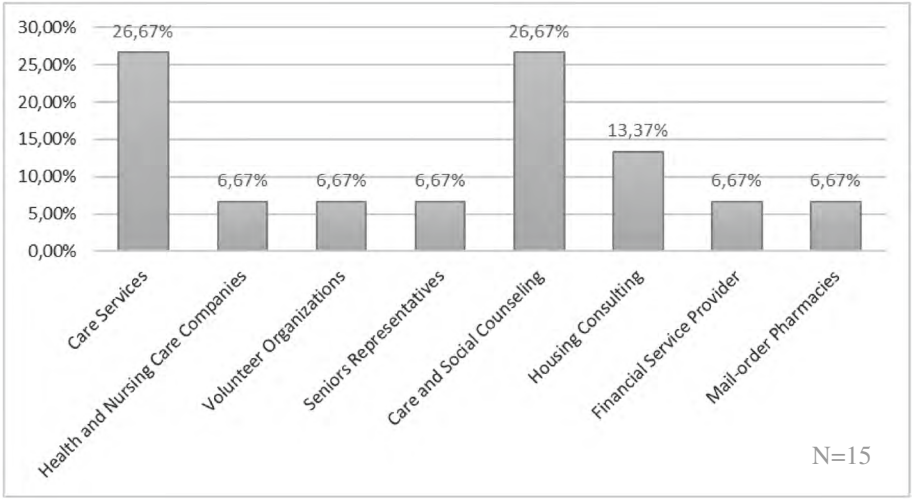


Fig. 2. Composition of the sample

Accordingly, the composition of the sample can be described as quite complex. The interviews were analyzed using MAXQDA software. Methodically, the interview material was coded according to the content analysis of Gläser and Laudel [15]. Accordingly, categories were defined a priori based on theoretical preliminary considerations. These were then supplemented with further categories during the evaluation process.

3 Results

This chapter begins by presenting the results of the competitor analysis. Then the results of the qualitative expert interviews are presented. The results of the competitor analysis

show that existing platforms mostly specialize in low-threshold care services and advice. On the other hand, information on assistance systems and products, as well as their booking, have hardly been offered by care platforms so far. Besides, most of the care platforms cannot be used via apps. The care platforms to date have not yet been able to establish themselves across the board, so there is still some potential for improvement. In particular, topics such as the financing of a care platform and the development of sustainable business models were identified as sticking points [16].

The evaluation of the qualitative interviews also revealed that there are needs that cannot yet be met by already existing platforms. Previous platforms were described as "insufficient" by the experts interviewed at the time of the interview. A holistic care platform was desired by the interviewees. On this platform, information should be presented in a well-prepared, bundled, easy-to-understand, and customized way for a broad target group, for example also via pictures, diagrams, or videos. This should help to counteract excessive demands and support people by quickly providing them with a good overview of, for example, funding opportunities, care providers, etc. The platform should also, if possible, provide information that is easy to understand. The platform should also offer personal or automated consultations, if possible.

For care providers, in particular, there is a great need to minimize the administrative and organizational effort through a platform solution and to make it more efficient. It is crucial to involve the providers in the development of the platform, as due to the excess demand in the field of care, they will only participate in a platform if it enables them to add significant value. From the interviewees' point of view, the platform should therefore enable the providers on the platform to manage bookings and appointments and thus ensure and implement a simplification and reduction of the administrative, contractual effort, e.g. through digital contract management, employee and customer management, tour planning, deployment planning/service schedules. In this context, invoicing of services via the platform should also be made possible. This would also have the advantage for people who need assistance to be able to book products and services directly via the platform and to manage contact data and appointments clearly in one place. Besides, communication, exchange, and networking opportunities should be created on the platform so that, for example, people with similar medical conditions, hobbies, or from the same city can network and exchange ideas. The platform should also support the decision-making process for a service or product, for example through recommendations or customer experiences.

One possibility would also be to implement a shop system for aids and technical assistance systems. Furthermore, some of the interviewees suggested an additional use via an app (possibly with voice control) to be able to access the platform on the move. The platform should also offer interfaces to other platforms and systems to make it accessible to as many people as possible. Overall, the experts interviewed had a similar idea of which services the platform should include and which aspects are important, although they come from different areas. Desired service priorities were advice, information, booking, administration, billing, and communication. A major topic during the qualitative interviews was ensuring the quality of the providers. From the interviewees' point of view, it would make sense for the providers to submit at least certificates of good conduct, diplomas, and further training certificates on the platform. Besides, there

could be training offers for carers and service providers. It would also make sense and be necessary to have quality assurance for technical devices, such as age-appropriate assisting systems, which are offered via the platform. At best, benchmarks would have to be developed to be able to evaluate the services and products as objectively as possible. The interviewees also emphasized that it is also important that the response speed to inquiries is high to be able to provide support quickly. The response speed of a provider is therefore also an important quality feature. An evaluation of the quality of the providers is very important because otherwise providers are usually selected through price comparisons. This could lead to dumping prices, which should be avoided. The platform should also be easy to use, which concerns the layout, i.e. a good overview, a certain size of the font, and intuitive operation, and the language should be easy to understand. In addition to German, it should be possible to select other languages on the platform. The aspect of financing is also identified by the respondents as a "sticking point" [16, 17].

4 Resume

The results show what needs and wishes people with assistance needs and their relatives have for a care platform, which are still covered by existing platforms. They also provide a good insight into the views of potential providers on the platform and their requirements. The results can therefore be used as an initial starting point for the development and design of a needs-based care platform. However, there is still a need for research on the part of persons with assistance needs and their relatives. Due to the Corona Protection Ordinance that will come into force in 2020, a direct survey of these groups of people was not conducted in the first step. Instead, when selecting the sample, care was taken to interview as many experts as possible who are in daily contact with these groups of people. The interviewees rated their knowledge about the needs of this target group as high. They reported that in their work they are often asked for help by persons with assistance needs and their relatives and therefore, due to their many years of experience, they are well able to describe the problems and wishes. Nevertheless, in the course of the project, these groups of people will also have their say. The aim is to check whether there are other needs and ideas for implementation that can be taken into account in the development of the platform [16, 17].

Overall, the user-centered approach to the development of the care platform was rated very positively by the experts. Furthermore, the respondents wanted to continue to be informed about the project and expressed their interest in being involved in further evaluation steps. Based on the analysis, the project team developed use cases for a holistic care platform. A first mock-up is currently being developed for this, which will then be evaluated. The further procedure will be based on the user-centered approach described in chapter 2. In parallel, an early focus will be placed on financing approaches and business models, as these aspects have been identified as particular challenges.

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Effects of Signal Latency on Human Performance in Teleoperations

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Abstract. Teleoperation offers a way to harness the collaborative benefits of machine precision and efficiency combined with human flexibility and cognitive abilities. One of the main technical challenges in teleoperation is signal latency; despite the large body of literature investigating this topic, there is relatively little exploration of why signal latency impacts human performance. Those few studies on human performance in teleoperations have focused on objective measurements in short duration scenarios, often performed by newbie participants in laboratory contexts and with well-defined targets and completion goals. This is in stark contrast with the characteristics of real-world teleoperation scenarios, where highly trained operators will perform longer tasks, concurrently, in noisy environments, with combinations of performance shaping factors such as fatigue, distraction, time pressure, stress, etc. In this paper, we propose a study to evaluate the effects of signal latency on human performance in simulated scenarios that more closely mirror real-world operations.

Keywords: Human-robot interaction · Teleoperations · Telerobotics · Human performance · Human-centered design · Signal latency

1 Introduction

An advantage offered by modern technology is the ability to teleoperate systems or machines; that is, to operate them remotely and/or from a distance. Teleoperation makes it possible to perform tasks that cannot be accomplished by humans alone [1] because the tasks are in a place that may be difficult or impossible to reach for the human (e.g., underground, underwater, or space operations), may compromise personnel safety (e.g., close to contamination or radiation hazards) or mission efficiency (e.g., routine small/short-duration tasks to be performed in a remote location), or may incur higher costs if they are performed in person [2]. We do not yet have the technological capability to develop fully autonomous robots that can perform complex tasks independently; as such human operators are still needed for tasks "for which each operational scenario is sufficiently different from its predecessor to make continual reprogramming impractical, or which demand a level of control judgement that cannot reasonably be replaced by machine intelligence" [3, p. 1258]. Some examples of complex teleoperation tasks that

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 386–393, 2022.
https://doi.org/10.1007/978-3-030-85540-6_50

still require a high degree of human intervention are telesurgery, rendezvous and docking of spacecraft, and underwater inspections [3].

From a technological perspective, one of the most significant challenges of teleoperations is signal latency [4]. Despite the large body of literature on this topic, there is relatively little exploration of the effects of signal latency on human performance beyond the observation that latency increases task time and can have an effect on accuracy for some tasks. It is our experience that a deeper exploration of human performance is important to fully understand and evaluate potential solutions to address the problem. As noted in [5, p. 493]: "Lag must be taken seriously and recognized as a major bottleneck for usability. The current attitude of acknowledging lag but 'learning to live with it' will be increasingly unacceptable."

In this paper, we explore the literature on the effects of signal latency on human performance and consider some additional research questions in this area. We discuss insights gained from previous studies on human performance and consider how these may be relevant to teleoperations. Finally, we describe a planned empirical study at the Institute for Energy Technology (IFE) in Norway, where we aim to take a human-centered approach to better understand the problem of signal latency in teleoperations.

2 Background

2.1 Signal Latency in Teleoperations

An essential aspect of teleoperations is the ability to easily communicate and interact with the robot. A particularly interesting challenge, therefore, is the effect on communication and interaction when signal latency (also called delay or lag) occurs. In teleoperation, latency refers to "the elapsed time between a user's action and the consequent system's observed response" [6, p. 1]. The effects of signal latency on teleoperations have been studied since the 1960s [7, 1989], and by the 1980s there was considerable evidence to demonstrate that latency, in particular time delay, was "a serious problem, a least one which could not be ignored" [8, p. 593]. Even today, time delay is "still an unsolved problem" [4, p. 1].

Latency occurs because of the sum of delays added by each part of the system. Everything from the systems used for capturing input, to processing, hardware and transmission will add to the total delay sum. For short-distance transmission, hardware and processing make up the bulk of delay added to the system, while for longer distances the signal propagation will add most of the delay, in addition to delays caused by repeaters and relays. Noise interference will also increase the time of critical packages since re-transmission is necessary.

New technology and user requirements have pushed the development of modern communication networks towards reducing signal latency. When Voice over IP (VoIP) was introduced in early 2000, a latency between 100–400 ms (ms) was observed to affect conversation. Thus, when designing 3rd and 4th generation mobile broadband, commonly known as 3G and 4G, designers aimed for latencies below 100 ms [9]. The fifth-generation mobile broadband, 5G, reduces latencies even further, enabling new use cases such as autonomous driving and remote surgery with a vision of end-to-end communication latencies below 1ms. But as mentioned in [10] all services over

proximal or long-distance communication networks are subject to latency. Therefore, different types of latency will still occur in modern communications systems, even 5G, depending on use cases and network architecture.

2.2 Effects of Signal Latency on Task and Human Performance

Unsurprisingly, if signal latency is present, this will result in tasks taking longer to complete. A delay of just 300 ms can produce an observable effect in operator behaviour, and a 1-s delay can make operators switch from continuous command mode to a "move and wait" strategy [11], i.e., "move a small distance and wait to see what happens" [7, p. 138]; also called "Start-and-Stop" [12]. In virtual environment simulations, it has been noted that people are capable of detecting latency as low as 10–20 ms [1]. One would expect that as latency increases, so too does the effect on human performance, but this is not necessarily the case. Simulations of driving tasks found that a latency of 170 ms was enough to significantly degrade the driver's vehicle control, but simulations of free flight control did not result in performance degradation until the latency reached between 1.5–3 s [1]. This appears to indicate that the effect of latency on human performance is also a product of the type and complexity of the task (and perhaps the experience and training of the person). A 2002 study of robotic manipulation tasks found that a 3-s delay when performing a generic box extraction task resulted in a 60% increase over the time taken to complete the task without delay [1]. However, a 3-s delay when performing a generic "peg in hole" positioning task resulted in an overall completion time increase of 213% [1].

Understanding and describing the specific characteristics of both the tasks and the types of delay can have a crucial impact on the findings in signal latency studies. For instance, [12] reported that the same increasing time delay intervals had different impacts when related to slowness of the movement (slow movement performance of the robot) or onset latency (time taken to initiate the movement commands). The findings showed that participants were able to mitigate slowness delays but not onset latency, which resulted in worse performance for the latter scenarios.

Signal latency may not always result in a fixed, constant time delay; sometimes, especially for Internet-based communications, the delay may be variable both in terms of when it occurs and for how long [11]. The literature reports yet another set of apparently contradictory results, with some studies reporting that operators make more errors when the latency is constant than when they experience variable latency [1] while others mention that variable latency leads to worse performance [13]. In [1] it is theorised that operators are more cautious when they experience variable latency, which is why they make fewer errors, while in [13] it is argued that users are less able to find an appropriate mitigation strategy with variable time delays. The nature of the tasks used in the studies can be significantly different, which suggests that we need to further explore both contextual and human factors aspects that can help us understand the apparent contradictions in findings.

2.3 Strategies to Mitigate Signal Latency

Since the mid-1950s, one of the prevailing theories of how to counteract the effects of latency has been the ability to predict the behaviour of the system being controlled. In [14, p. 268] it is stated that "predictive behaviour on the part of [the subject] is essential for skilled performance." In [15, p. 29] the authors note that when operators use the "move and wait" strategy, it "appears possible to predict average completion times for simple manipulative tasks." Since then, the development of predictive models and displays for teleoperations has dominated the literature; for example, [1–3, 6–8, 16].

The concept of supervisory control was introduced as another way of compensating for time delays in teleoperated systems [17]. In this method, the overall teleoperated activity is divided into a sequence of tasks that the robot performs on its own, supervised by the human [18]. The human may occasionally intervene or control some variables, and planning the task is performed primarily by the human, which is what tends to differentiate supervisory control from fully autonomous control. However, if the robot experiences some difficulty during the task, the only choices are "to continue performing poorly or to stop" [18, p. 4].

In recent years, attention has turned to machine learning methods as a means of compensating for time delay, primarily statistical or neural network models [4]. These methods attempt to predict future behaviours of the robot or even of the human operator. There are some disadvantages related to the ability of these models to perform longer-term predictions or to model more complex tasks, as well as the more universal "black box" problem which is typical of many advanced machine learning methods; that is, the lack of understanding about the relationship between the model inputs and outputs. Regardless, these methods are generally viewed as a promising area of research [4].

3 A Human-Centered Approach to the Problem

Known performance effects of teleoperations on human operators can include fatigue and high cognitive load [1, 6, 19]. This may be caused by the user interface [20], or because the operator is required to memorize the task plan and keep track of numerous information sources [6], or even because of the cognitive demands associated with having to control a complex robot [21]. Related to fatigue is the operator's experience of higher workload "because he or she often has to switch among different camera views and/or manoeuvre the robots with a time delay due to technological limitations" [1].

It is reasonable to assume that the addition of signal latency will further compound the likelihood and detrimental effects of fatigue and cognitive workload, since it means that tasks will take longer to complete, not to mention that it probably also creates frustration and uncertainty with the task. A study by the Institute for Transport Economics in Norway [22, p. 56] found that, in driving simulator studies, "time on task itself produces fatigue-related performance decrements." The study report notes that simple or familiar tasks can be easily executed by drivers, even after sleep deprivation or prolonged performance of a demanding task, but "complex tasks requiring deliberate control of behaviour (e.g., new or unfamiliar tasks) are more difficult to perform" [22].

A study [23] on conditional automated driving (CAD) found that there was a difference in driver performance between short-term and long-term driving scenarios. The

authors note that in real-world applications of CAD, there are likely to be prolonged periods of automated driving during which time the driver will become less attentive because the monitoring task becomes monotonous; "increasing automation and monotony are two known causations for fatigue" [23, p. 5]. This can subsequently result in delayed driver response and negatively impact their take-over performance when required. This echoes the finding of [21] in which the authors note that "when traditionally applying automation to a telerobot, responsibility for as many system functions as possible is delegated to a computer and whatever is leftover is given to the human operator. The 'left-over' is usually the function of systems monitoring, a task for which it is difficult to develop artificial intelligence or expert systems to accomplish. But this is a function that humans are generally ill suited to perform due to extreme susceptibility to vigilance decrements and waning attention" [21, p. 410].

In [21, p. 423] a curious finding is reported, related to predictive modelling methods: "although the system did allow for operator advanced planning of telerobot moves, the participants seldom took advantage of this capability, often waiting for processing of a particular sequence to finish to ensure its success (safety). They tended to adopt a "move and wait" strategy, which is commonly observed in actual teleoperations with control lag." This finding seems especially important for those safety-critical industries that utilise teleoperations and may be considering integration of predictive methods to mitigate the effects of signal latency.

Many of the studies on human performance in teleoperation settings have focused on objective measurements such as response times and sub-task accuracy in short duration scenarios, often performed by newbie participants in laboratory contexts and with well-defined targets and completion goals [1]. We argue, however, that this might not correspond to the requirements for real-world operations [8]. Common across application areas are the following aspects: a) highly specialized and trained operators are responsible for teleoperations; b) task duration can be very long, requiring sustained attention and awareness from the operator; c) there can be a variety of tasks that the operator needs to perform including navigation (sometimes in uncertain types of terrain), mapping (based on sensor information only), information acquisition (checking specific parameters at the site) and even manipulation tasks (opening doors, moving obstacles, operating levers and controls); d) goal definition can also vary from clearly specified tasks (like docking) or can be highly undefined such as in search and rescue operations, where both the environment and the end of the mission can be unspecified, requiring decision protocols; e) one operator might not be dedicated to the teleoperation task only, having several other tasks to perform.

These factors can all be critical from a human-centered approach, impacting accuracy, response times, attention, situation awareness, workload, fatigue, frustration, and ability to perform the tasks as expected. Moreover, the imposed urgency of most real-world teleoperation tasks can also have relevant interaction effects. Aspects such as the cost of the mission and the equipment used, the time pressure to complete a task, or natural distraction and interruption resulting from working in busy (and often loud) contexts can make real-world operations quite different from the controlled scenarios tested in laboratorial settings. As such we intend to conduct a preliminary study to simulate the complexity of real-world scenarios.

4 Planning an Empirical Study

Lessons learned from human performance studies suggest that techno-centric solutions aimed at mitigating the immediate effects of signal latency may, at best, be ineffectual in real-world applications and, at worst, actually induce new human factors problems. Adopting a human-centric approach to mitigating the effects of signal latency enables a broader consideration of the performance effects, including identification of hidden human error modes, to develop a more user-friendly, useful solution that applies to real-world operations.

At IFE, we are planning an initial study to test the robustness of the findings we have presented in this paper. Rather than studying the effects of single performance shaping factors in a highly controlled environment, we aim to recreate a real-world experience where study participants will remotely control a (relatively) expensive robot (TIAGo[1]) through a series of navigation and perception tasks in a noisy environment with induced combinations of factors such as signal latency, distractions, memory tasks, concurrent tasks, and time pressure.

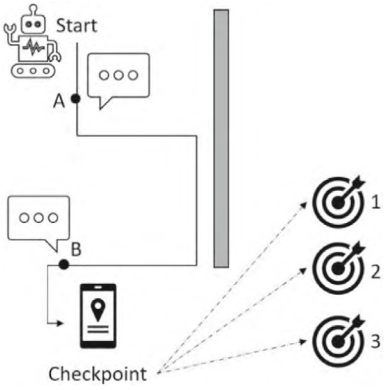


Fig. 1. Example test-setup.

Figure 1 shows an example test set-up. In this test, the participant will remotely navigate the robot along a pre-defined path (indicated by the solid line arrow) to a checkpoint, and from there to one of three targets as instructed. At the target, the participant will manipulate the camera on the robot head to find a specific number code that must be scanned by the robot camera to end the scenario. En route to the checkpoint, the participant will receive a verbal instruction at point A, which will inform them of which target to go to and which code to scan (e.g., "Go to target 3 and scan code 1732") and, later, a verbal interruption at point B, designed to distract and induce time pressure (e.g., "Where are you now? Did you go to <wrong target>? How much longer?"). The task will be performed in an environment with background noise and the participant will not be able to "see" the targets via the robot cameras until they reach the checkpoint.

[1] https://pal-robotics.com/robots/tiago/.

The participant will perform one variation of the scenario with no noise, no interruptions, and no signal latency to establish a baseline. In the next scenario, background noise, time pressure, and the verbal interruption will be introduced, and the performance effects will be measured. In the third scenario, signal latency will be added to the combination of factors, and again the performance effects will be measured. To reduce any potential learning effect, the scenarios will be randomised, both in terms of when variables are introduced, the pre-defined paths that the robot must follow, and the location of targets and number codes.

In this initial study, we aim to explore the following research questions: (i) what effects do the induced factors have on the participant's experience and performance a) without latency and b) with latency? And (ii) does the participant adjust their behaviour in any way (other than the typical "move-and-wait" strategy) to compensate for or otherwise attempt to mitigate the signal latency? The effects on human performance will be determined using the NASA TLX scales to measure, e.g., frustration, cognitive load, physical load, performance, and effort. Accuracy (i.e., did they go to the correct target; did they scan the correct code?) will also be measured, as well as the time taken to complete the scenario. Debrief interviews will be conducted at the end of the study.

5 Conclusions

Signal latency is still problematic for teleoperations and attempts to develop solutions have tended to be techno-centric, rather than aimed at addressing the underlying human performance issues. Because of this, there are questions about how well these solutions will work in real-world applications, or whether the solutions themselves could create new error-producing conditions. In our paper, we argue that it is crucial to understand signal latency in the context of, and in combination with, other known performance issues that arise from human-system/automation interaction and teleoperations specifically. Issues such as fatigue, cognitive workload, stress, distraction, and boredom are all likely to affect operators and may reduce the effectiveness of techno-centric solutions. We outline our research hypothesis and research questions for a small-scale study of teleoperations using the TIAGo robot, to begin our exploration of the user experience of signal latency in combination with other real-world performance factors.

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Website Aesthetics and Functional User States as Factors of Web Usability

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Abstract. In web usability studies, a 'contextual fidelity' model identifies four factors that significantly affects testing accuracy: web aesthetics; testing environment and circumstances; participants' personality traits and user states; and the nature of test task. In most works, these factors are considered independent; however, this has never been properly tested. To partly cover this gap, we experimentally test the one-directional effects of web aesthetics and task nature upon user states. Of dysfunctional user states described in literature, we have chosen monotony and anxiety, both equally damaging for user experience but differing by cognitive strategy. By combining high/low-quality web aesthetics and tasks directed to monotony/anxiety, we show that these two factors condition each other in users' action. To detect monotony and anxiety, we measured cognitive efficiency and emotional stress. 48 student assessors divided into 4 groups were involved in the experiment. Our results shown that, counter-intuitively, the impact of website aesthetics on user states differs in cognitive performance and not in emotional stress. In the case of anxiety, high quality of design provokes hyper-lability of attention, does not contribute to its concentration, and reduces productivity. In the case of monotony, the aesthetic layout dramatically reduces the rate of fatigue and increases productivity. Our results prove that web aesthetics has a non-negligible impact upon more rational decision-making of users, which was overlooked in previous studies.

Keywords: Web usability · Web design · Web aesthetics · User states

1 Introduction

In the modern research on accuracy of usability testing, contextual factors of the testing process are seen as significantly shaping the rest results. Thus, a four-factor 'contextual fidelity' model has been elaborated for web usability studies. It identifies four factors that can significantly affect testing accuracy. These factors are: (1) web aesthetics; (2) test environment and circumstances of testing; (3) participants' personality traits and user states; and (4) the nature and shape of test task. Among those, the website aesthetics and the state of the user stand out [1–3].

Most authors consider important the influence of aesthetics upon objective criteria of usability, in particular, on user productivity. In studies like this, it is common to

© The Author(s), under exclusive license to Springer Nature Switzerland AG 2022
T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 394–401, 2022.
https://doi.org/10.1007/978-3-030-85540-6_51

measure user performance as a function of aesthetics. However, as evidenced by the results of these studies, there are conflicting views upon the relationship between web aesthetics and user performance. Some authors [4] postulate direct relationship between the aesthetic quality of a layout and decrease in performance, while others refute it [5]. Therefore, we need to understand in which cases the aesthetics of a website increases user performance and in which cases the former reduces the latter.

Moreover, the connection between the two aforementioned 'contextual fidelity' factors, namely the state of the user during the task completion procedure and the aesthetic quality of the web design, remains undisclosed. This is mostly due to the researchers' view of the 'contextual fidelity' factors as independent.

User states are functional states of mood and cognition which directly and critically affect task completion. Thus, studies have repeatedly discussed issues related to various effects of user states, e.g., the influence of user incompetence on his/her motivation and self-efficacy [6–8]; however, none of these studies considered aesthetic factors as crucial for user states. It is only in rare works that the two factors are seen as interrelated (see below), and these works provide mixed and counter-intuitive results. Moreover, the nature of the task that users perform may evidently also affect the user state (and, thus, user performance) just as well.

To partly cover this gap, we test the one-directional effects of web aesthetics and task nature upon user states, without testing the reciprocal effects. We have developed an experiment to demonstrate the impact of the aesthetic quality of web design and task nature upon user states during the task completion.

The paper proceeds as follows. Section 2 describes the approaches to assessment of inter-related 'contextual fidelity' factors, including user functional states and web aesthetics. Section 3 describes the experiment and its settings, the assessor groups, and conduct of tests. Section 4 provides the results of the experiment, followed by a conclusion.

2 Inter-relating Web Aesthetics, Task Nature, and the Resulting User States

2.1 Inter-relations Between the 'Contextual Fidelity' Factors

As already stated above, only rare works consider 'contextual fidelity' factors as interconnected and casting impact upon each other. Thus, a study by Sauer and Sonderegger [9] has revealed complicated relationship between web design, perceived usability, user performance, and problem-solving experience. It has shown that high aesthetic quality of a web product increases perceived usability but, paradoxically, decreases productivity.

Commenting on this study, we can note the following.

First, it puts frustration to the center of user experience. This is commonsensical but does not take into account the specificity of other tasks and other possible resulting states. However, the patterns of such states can be very different from each other and from frustration.

Second, the relationship between page layout and the overall web design and the dynamic user state remains undisclosed. In particular, the role of design in the formation of negative states generated by the task features is unclear.

These remarks are true for other similar studies. Most of them deal specifically with design effects, especially the impact of web design quality upon user performance. As a rule, such effects are manifested in favorable functional states, such as operational comfort. However, this does not sufficiently take into account the effects of the task itself, while they evidently entail significant changes in the psychological state of the user.

In addition, high quality of webpage design can also affect the user's performance under certain conditions. At the same time, the functionality of the design manifests itself in objective parameters. First of all, it manifests in an increase in productivity, as a result of which the user makes fewer mistakes, spends less time on solving the problem and has a pronounced operational strategy. Consequently, the factor of web aesthetics should be taken into account in the dynamics of functional states, especially unfavorable ones.

Thus, in the studies that assess user state as a factor of productivity along with web design quality, user experience is presented in a rather narrow way. And today there is a shortage of works that would estimate the impact of web aesthetics upon the dynamics of user experience when various unfavorable functional states form. In this regard, it is of particular relevance to study how the functional significance of the aesthetic quality of web design manifests itself in the dynamics of user experience during task performance.

2.2 User States and Their Dynamics During Task Completion

To evaluate the state of user during task completion, we have chosen the theory of operator functional states [10], as established by Leonova and colleagues for assessment of operational stress in operators' performance in various jobs [11, 12]. This theory describes the cognitive states of workers at various jobs and links them to the workers' functionality during job task performance; we apply this theory for the DUXU area, as we see it as systematic and potentially highly productive for assessment of user states during the task performance, as well as for investigating the role of web aesthetics and task nature in users' functional behavior.

The Leonova's and her disciples' theory describes several dysfunctional user states, including anxiety, fatigue, monotony, and satiation [13]. To measure the dependence of the users' state on the aesthetic quality of web design in the process of solving the problem, we have chosen two opposite functional-cognitive modes, namely monotony and anxiety. Each of these states has a stable set of features that form in user experience when solving certain types of web assessment tasks and are equally damaging for user experience but differ by cognitive strategy. Monotony as a psychic state implies apathy, drop of self-control, boredom, and stereotyped action. Contrary to that, anxiety implies hyper-reaction, impulsivity, and growth of error rate. The pattern of monotony also implies a large number of simple and monotonous movements in structure with an insignificant creative component.

As a rule, the functional state of anxiety is formed in conditions of a lack of time and information when solving a problem. Also, the development of this state may be associated with unforeseen changes in operating modes. This may be, e.g., sharp increase in the complexity of the task or a sudden change in its conditions with a simultaneous reduction in the time to solve.

In both cases, user experience by the end of the task solution procedure of a problem is qualitatively different from the starting level.

2.3 Web Aesthetics and its Quantitative Measurement

In 2016 to 2019, we have suggested an approach to quantitative assessment of aesthetic harmony of web page design [3]. For this, we have developed a U-index which included micro- and macro-parameters of the web page (Umin and Umax parts of the U-index, respectively), as based on academic and industrial literature on aesthetically perfect web design and layouting [14]. U-index was empirically tested in terms of user satisfaction and objective quality of task performance.

3 Method

3.1 The Research Hypotheses

Taking into account the above, we proceeded from the following question: How does the aesthetic quality of web design affect user performance in unfavorable conditions manifested via the functional states of monotony and anxiety?

In accordance with this question, we have put forward two hypotheses:

H1: in conditions of anxiety, a high aesthetic quality of design reduces the level of emotional stress and increases intellectual lability;
H2: in monotonous conditions, the high aesthetic quality of design increases the level of emotional stress and does not significantly affect intellectual lability.

3.2 Measures and Instruments

As stated above, the assessment of the aesthetic quality of the web design was carried out using the integral index of web page usability (U-index) [3, 14].

To measure the quality of user experience, we first needed to select indicators characteristic of certain functional states. Thus, to detect monotony and anxiety, we measured cognitive efficiency (via intellectual lability) and emotional condition (by four indicators).

3.2.1 Intellectual Lability Measurement

This metric characterizes the ability to switch attention, the ability to quickly switch from solving some tasks to performing others, while avoiding mistakes. According to the theory of functional states, a high level of anxiety provokes impulsivity and an excessively high rate of reactions, while, in case of monotony, the rate decreases to the point of apathy. We propose to measure this indicator using the test for switching attention known as the 'Gorbov – Schulte table' [15] before and after the experiment.

3.2.2 Emotional Condition Metrics

This group includes four metrics that add up to an integral indicator of the user's emotional state. In accordance with the method of self-assessment of emotional states [16], we propose to measure the level of anxiety (the 'calmness/anxiety' scale), fatigue (the 'energy/fatigue' scale), arousal (the 'excitement/depression' scale), and confidence (the 'self-confidence/helplessness' scale).

3.3 Experimental Design and Procedures

To test our hypotheses, the websites of two universities were chosen that had different levels of aesthetic excellence (high and low), as based on U-index. We developed a 2 × 2 study design. The test tasks were performed in four groups of 12 assessors each, two of which worked with an item on the formation of anxiety, and two on the formation of monotony. In each assignment, one group worked with the high aesthetic quality site (U-index > 17) and the other with the low-quality one (U-index < 8).

In accordance with the questions posed, we developed the structure of the experiment made of the following stages.

1. Entrance testing to fix the starting indicators of cognitive efficiency and emotional stress in the state of 'operational comfort' of each user:
   - assessment of the current level of emotional stress (test 'Self-assessment of emotional states' [16]);
   - test for intellectual lability ('Gorbov – Schulte table' [15]).
2. Fulfillment of tasks for the formation of unfavorable functional states (anxiety and monotony) on the websites of different aesthetic quality.
3. Final testing in the same order to record changes in the indicators of cognitive efficiency and emotional stress of each user in relation to the starting stage.

3.4 Experimental Tasks

The experiment uses two types of tasks aimed at creating a negative user experience.

During the execution of the task focused on the formation of anxiety, each user needs to find the specified content on the webpage of the corresponding aesthetic quality within 10 min. Three minutes after the start of the search, the curator of the experiment announces the change in the purpose of the search and a reduction in the time to 5 min. During the execution of the task aimed at the formation of monotony, each user was asked to prepare a full text version of the site of the corresponding aesthetic quality (in the.doc format) within one hour. The exact time of completion of the task (35 min) was not reported.

4 Results

4.1 Intellectual Lability

As the results of the study show (see Table 1), the layout of high aesthetic quality is characterized by a more significant effect on the cognitive efficiency of the assessors. There is an increase in the average value of intellectual lability both when performing the task of forming monotony (187.7/192) and anxiety (184,9/210.4). At the same time, in other cases, there is either a regular decrease (187/179 – Umin, 'monotony') or the absence of a corresponding reaction (188.1/188.7 – Umin, 'anxiety'). Thus, the influence of web aesthetics on the users' cognitive efficiency turns out to be significant regardless of the quality of the unfavorable experience, although to a different extent: the state of anxiety is characterized by hyperlability of attention, while, in case of monotony, the growth of this indicator turns out to be more moderate. This is somewhat in conflict with studies that have shown a direct relationship between the aesthetic quality of a layout and reduced performance. In general, this fact partially confirms hypothesis **H1** in its cognitive aspect, and partially refutes hypothesis **H2**.

4.2 Emotional State

Among the indicators related to the emotional state of users, we need to underline the growth of emotional stress when performing a task aimed at the formation of anxiety at the website of high aesthetic quality (by the anxiety scale: 6.85/5.74). This contradicts the **H1** hypothesis that implied a compensatory effect of web aesthetics on emotional stress under stressful work conditions.

Table 1. The results of the experiment

Dysfunctional state	Metrics		Aesthetic design		Non-aesthetic design	
Monotony	Intellectual lability		187,7	192	187	179
	Emotional state	Anxiety	6,85	6,71	6,57	7
		Fatigue	6,71	6,85	7	5,4
		Excitement	7	6,714	6	6
		Confidence	6,85	6,85	7	7
Anxiety	Intellectual lability		184,9	210,4 210,4	188,1	188,7
	Emotional state	Anxiety	6,85	6,85	6,85	5,714
		Fatigue	7	7	6,85	6,714
		Excitement	6,85	6,85	6,85	6,85
		Confidence	7	7	7	6

Obviously, an increase in anxiety in stress indicators is associated with a feeling of self-doubt after the test. At the same time, a decrease in the level of confidence (7/6) is

observed. It should also be noted that there is a slight increase in the indicator on the 'anxiety' scale for monotony (6.57/7) which allows for confirmation of hypothesis **H2** in the part corresponding to the prediction of emotional stress for this type of tasks.

5 Conclusion

Test results have shown that, counter-intuitively, the impact of website aesthetics on states of anxiety and monotony differs in cognitive performance and not in emotional stress. In the case of anxiety, high quality of design provokes hyper-lability of attention, does not contribute to its concentration, and reduces productivity. In the case of monotony, the aesthetic layout dramatically reduces the rate of fatigue and increases productivity. Our results prove that web aesthetics has a non-negligible impact upon more rational decision-making of users, which was overlooked in previous studies.

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Lean Manufacturing Model of Production Management Make to Order Based on QRM to Reduce Order Delivery Times in Metal-Mechanical SMEs

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Abstract. Factors such as the lack of standardization of processes and unproductive times in manufacturing companies cause deficiencies in production processes, this in turn causes delays in the delivery of finished products. Given the problem, the use of Lean-QRM is proposed as a solution model to reduce the delivery times of orders in SMEs, both methodologies complement each other and are aimed at improving efficiency in companies with production-to-order systems. For this reason, the research carried out seeks to implement a model focusing on increasing efficiency in the production area of the company under study in order to improve the performance of on-time deliveries (OTD). The results suggest a minimum increase of 1.5% in the delivery of orders on time.

Keywords: OTD · Metalworking · Lean manufacturing · QRM · SMED

1 Introduction

Currently, the metalworking sector has crucial functions in the country since it is one of the main suppliers of capital goods, among these are spare parts, equipment, tools, articles and industrial supplies for companies of any size in the mining, transportation and fishing [1]. Likewise, this sector is one of the main generators of work. In Peru, this industry represents an important production pillar of the economy, since the metalworking industry represents 12% of total manufacturing production (GVA) and contributes 1.6% of gross domestic product (GDP) [2]. On the other hand, the metalworking sector industry has presented deficiencies in its production systems due to different factors such as lack of infrastructure, obsolete machinery, among others [3]. However, lately it has been gradually recovering thanks to the dynamism of the mining and construction sectors, the metalworking sector managed to increase its production by approximately

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 402–409, 2022.
https://doi.org/10.1007/978-3-030-85540-6_52

6.5% in 2018, the most demanded goods were the increase in the production of engines, spare parts, turbines, electrical transformers and the growth of works such as buildings, commercial and industrial centers [4]. During 2015 there were industrial subsectors with low average efficiency where the subsector of production of metallic products and common metals was found with 17%, which turns out to be too significant for the industry. [5] SMEs represent a large percentage of GDP, currently small and medium-sized companies have difficulties to be competitive and productive. Among the limitations that SMEs have are the lack of financing, innovation, training, technology, culture and knowledge of the global market [6].

On the other hand, there are techniques that can help solve the problems in the production processes of these companies, which generally occur due to unproductive times in the manufacture of products or poor planning and control of the processes [7]. One of the techniques used to mitigate the problem in production processes is Lean Manufacturing, due to the fact that it has had more success stories seen in the literature review.

In this research, a Lean Manufacturing model based on rapid response manufacturing (QRM) is proposed as an alternative solution, since QRM serves as a complement and covers the deficiencies that Lean Manufacturing has [8]. QRM integrates all areas of the company to achieve goals and meet deliveries on time in a production-to-order (MTO) environment. Based on the above, the main motivation is to achieve greater productivity and efficiency in operations, thus obtaining cost savings and an increase in deliveries on time [9].

2 Estate of the Art

2.1 Production Management Model of Metalworking SMEs

The SMEs in this area have an important development for a global improvement in the economic and social aspects in the current economy, since it is one of those that contributes the greatest contribution to the gross domestic product and jobs of the private sector in the world economy. Other authors point out the importance of identifying processes, which do not add value to the final product and/or activities that generate waste. For this reason, the objective that the production models must take into account should be based primarily on the elimination of these activities, in order to obtain an improvement in the efficiency of the organization's production [6, 10].

The authors agree that the primary goal in a production management model is to eliminate "waste" in order to provide customers with the best quality of service and delivery time at the lowest possible cost. This will generate a positive impact with respect to the competitors in the reduction of production times [5, 6]. Likewise, other authors assert that, to maintain the level of competitiveness, it is necessary for the company to improve the work carried out so far and to be able to satisfy the client's needs. Which the purpose of current companies is to identify non-value-added activities (NVA) of the central manufacturing process and eliminate them through organized procedures in a manufacturing company in order to significantly increase production [10, 11].

2.2 Lean Manufacturing

The authors agree that the objective of this technique is to achieve greater productivity in people and in manufacturing processes and/or performance of services in most industrial sectors. Therefore, this technique generates a great impact on the change of a more organized and optimal management system, focusing on reducing production times and improving market expectations [11, 12]. The important aspects of this technique are the use of the different tools that have been implemented in different cases, where most experts have used VSM, Process Standardization, SMED, Kanban, Kaizen, Heijunka and Jidoka. The idea shared by the different experts is that the final objective of the use of Lean manufacturing tools is based on generating a new culture of improvement based on communication and teamwork, for which it is necessary to adapt methods to each case concrete.

Most authors agree that the smed concept is a scientific approach to reducing set-up time that can be applied in any factory and also on any machine. It is a very effective tool in reducing times and its main goal is to do the activities for a grade or product change in less than 10 min [11, 13]. Value Stream Mapping [VSM] which is a widely used and contextualized tool by various authors, in which they agree that its main objective is to carry out a general mapping of the value flow of each product to be made [13]. The results obtained in the application of this tool in different companies have given optimal results with respect to the reduction of the production cycle time, where an increase in the productivity of the process was registered by 6.5% [11, 14].

2.3 Rapid Response Manufacturing (QRM)

Different authors agree that the QRM theme is defined as a transformation of traditional departments into so-called QRM units. Likewise, it is determined in the authors' opinion that by implementing the QRM system, the time spent in the production process can be greatly reduced from product design to delivery of the product to the customer. Compared to other companies, this reduction is certainly a huge competitive advantage and the cost is lower [15, 16].

According to the authors, the methodology of Quick Response Manufacturing (QRM) or rapid response manufacturing is a methodology that allows streamlining the optimization of processes based on time, the structure of the organization, system dynamics and the application for the entire business. The most outstanding results show a considerable improvement in these companies, increasing efficiency by 7%, increasing orders by 42% and average delivery time [OTD], which are the objectives of this methodology [17].

2.4 Lean-Rapid Response Manufacturing (QRM)

The applications of this model support that the QRM is a method that seeks new execution methods and focuses mainly on the reduction of time and reserves of reserve capacity as the main indicator, it involves suppliers and buyers in the QRM program. Unlike lean which is in high volume, repetitive production, and basic tools such as Takt Time and

level scheduling are designed to eliminate variability in operations and create a better production flow [13, 14].

The papers point out that while other management models are designed for regular and predictable demand, many products have easy-to-standardize mass production and quick-response manufacturing, the QRM is designed for a environment with irregular requirements, unpredictable [12, 13]. The application of this combination has improved in some companies under study the percentage of fulfillment of deliveries on time [OTD] and increased by 15% the level of care [16–18].

3 Input

3.1 Proposed Model

The proposed model is a proposal for the solution of the problems identified above, which is based on an input and output model of the most necessary data that will be measured to check if the required objectives are met. The company's system adopts specific input elements such as the production quantity, machinery capacity and production cycle time, where when carrying out the processes detailed in the scheme, a transformation or change is generated with the expected results (Fig. 1).

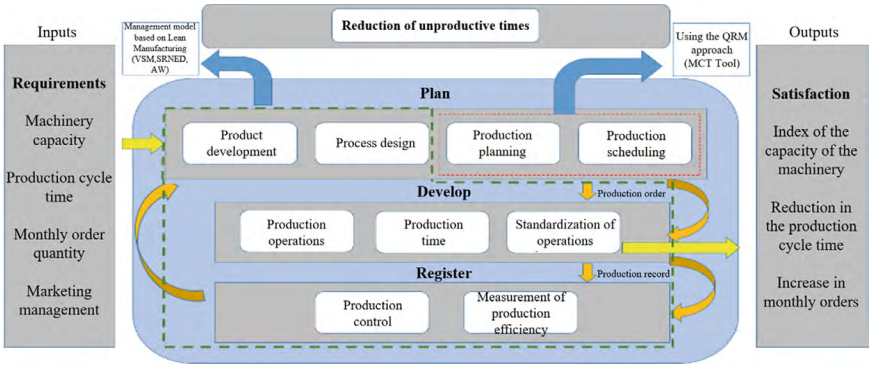


Fig. 1. Proposed model

3.2 Model Detail

The proposal is divided into 3 corresponding phases where the necessary steps for the implementation of the proposed model are grouped, ensuring that the corresponding objectives are met.

In the first phase, there is the preliminary stage where it is sought to show and explain the proposal taking into account the new designs of the processes. In the next phase, the application of the lean approach tools has been defined, where we begin by applying a VSM to know the current diagnosis of the organization.

After that, the famous tools such as work standardization, SMED and inventory control will be applied. Finally, in the last stage of the proposed model, it will be sought to measure and control the efficiency of the production processes through key performance indicators, where it will be recorded and verified in the final matrix of the fulfillment of the objectives:

3.3 Proposed Process

The process that is detailed in the figure is a continuous improvement cycle, which will serve as a guide for those companies that seek to maximize and refine their production processes, this process seeks to be applied in SMEs with a production-to-order system, since For the most part, these companies present an unpredictable demand for which the companies do not comply with what is planned and receive sanctions and/or penalties for doing so. Therefore, the priority of this planned model is to reduce the number of backorders.

3.4 Model Indicators

To show the effectiveness of the proposed model, the existence of key performance indicators is essential [8] (Table 1):

Table 1. Indicators

Metrics	Objective	Validation range	
Efficiency	57.05%	Good: Regular: Bad:	>= 57.05% [50%;57%] <= 49.18%
Deliveries on time	90.43%	Good: Regular: Bad:	>= 90.43% [85%;90%] <= 84.33%
Production capacity	235 unit	Good: Regular: Bad:	>= 228 227 <= 226

4 Validation

4.1 Case Study

The company in which we will validate our proposed production model is the company M & Burga S.A.C. This is a small metalworking company located in Chorrillos specialized in manufacturing spare parts for heavy machinery (mostly machinery for mining activities), metal structures, where its highest income is obtained from the sale of metal pins.

To obtain the final values of the variables in the respective indicators with the production management model and for the validation of the expected results, the Arena 16.0 software simulator was used to check the output data with the proposed improvement, where the Input of the current data of the production times in each one of the areas for the manufacture of the metallic pins. The validation of the proposed scenarios, three different scenarios were taken into account. The first consists of the current scenario of the organization where the data obtained is based on the year 2019. The second scenario represents the simulation with the implementation of the Lean-QRM production management model. Finally, the third scenario consists of the improvement focused on a single machine, which is the grinding machine, since this is where the workload accumulates due to the outsourced heat treatment process.

4.2 Initial Diagnosis

Companies in the manufacturing sector have obtained an average order fulfillment rate of 96.5% in the last 5 years. However, the company under study only has 75.33% of orders fulfilled, the data obtained was obtained with the following formula:

$$\%fulfillment = \frac{Orders\ on\ time}{Total\ orders} \tag{1}$$

$$\%\ \text{fulfillment} = 101/134 = 75.33\%$$

4.3 Validation Design

4.3.1 Value Stream Map (VSM)

In this step, data must be calculated and collected to prepare the Value Flow Map. Each of the operations and times of each of the activities dedicated to the manufacture of pins must be taken into account. These activities must be completed by the person in charge of production, carefully observing the process and with a stopwatch at hand, he must recognize that actions represent an operation, verification, delay, transport or storage. Subsequently, after data collection, the current state map is prepared and analyzed considering each of the elements previously explained by the person in charge of production, the VSM will represent the figure of what is happening in the company M & Burga SAC (Table 2).

Table 2. Value stream map

Indicators	Products	Current simulation	Future simulation	Variation
System time (hours)	Pines	55.3	44.4	−20%
Value added time (min)	Pines	46.1	37.4	−19%

4.3.2 Work Standardization (SW) and SMED

In the research stage, after analyzing the current value stream map, it is known that the existing bottleneck occurs in the turning process, also there are no defined work methods which are generating activities that do not generate value in the process. process. For the application of the SMED, in order to be able to develop this methodology in the company under study, the implementation model proposed by [2] will be taken as a basis, this model has been adapted to this particular case adding some improvements, such as the use of the DMAIC [Definition-Measurement-Analysis-Improvement-Control] methodology so that there is a better order and follow-up in the application of this tool (Table 3).

Table 3. Work Standardization (SW) and SMED

Indicators	Products	Current simulation	Future simulation	Variation
Time set-up (min)	Pines	48.6	24.1	−50%
Downtime (min)	Pines	49.24	16.47	−67%

5 Conclusions

The general conclusions regarding the simulation and which has had a positive impact on the company are the following:

With the implementation of the proposed Lean-QRM model, it was possible to increase the fulfillment of deliveries on time to 85%, this was due to the elimination of those activities that did not generate value in the production process.

It can be concluded that the project is economically viable with a projection of 4 years, given that a Net Present Value of 49,217.48 was obtained. Likewise, the RBC indicates that for each sun invested a profit of S/1.86 will be obtained.

Based on the simulation proposed in the project, an improvement can be observed with respect to the batch orders made to the company, reducing the production time of a batch by approximately 10.9 h (decrease of 19.71%), thereby achieving increase the number of orders fulfilled on time by completing 95% of the orders received per month.

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Lean Maintenance Management Model, Based on TPM and 5S to Increase the Availability of Machines in the Plastics Industry

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Abstract. In a production system in the plastics industry, the implementation of the Lean Manufacturing tool is carried out with a view to reducing machine downtime, because there is a relatively low availability rate, which is generated by breakdowns constant and prolonged time in its restoration. With the application of the Total Productive Maintenance technique focused on the criticality analysis of modes, effects and failures. It seeks to reduce the six major losses of equipment, through the timely identification of the main causes of unforeseen breakdowns, which affects the availability of machines and their productivity and increases production costs. The Solution model will be implemented in three of these: First, the preparation stage. Then, the implementation stage that consists of the development of two methodology that is Total Productive Maintenance and 5S. Finally, the monitoring stage that allows the indicators to be compared with the improved line.

Keywords: Lean manufacturing · Total productive maintenance (TPM) · 5S · Availability

1 Introduction

Today, a need arises to improve the productive processes of the industries due to the presence of globalization, since competition is increasing every day due to the fact that many new companies arise, which is why it is important to keep production costs low. Industries concentrate efforts on maintaining a more efficient and productive production system, to avoid losing profits and becoming more profitable, in order to stay in competition [1]. Industries in their quest to increase their productivity and obtain higher income, seek to eliminate their problems that generate waste. Industries that treat plastics are generally characterized by pinching machines. In these machines, the operating methods can be very complex. Therefore, a machine failure would greatly affect the performance caused by the time required to know the factors that explain the downtime. Machine

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 410–416, 2022.
https://doi.org/10.1007/978-3-030-85540-6_53

downtime refers to downtime periods when machines are not productive Industries need to be aware that machine downtime already whether planned or not, it is very expensive.

From the costs of production downtime, labor, and reserve value, the cost of downtime extends to other resources within the facility, as well as to the organization as a whole [2]. Also, reducing downtime increases machine availability, reduces order delivery times, and increases customer satisfaction. Causes of machine downtime can include problems with real machines such as breakdowns or jams, no materials, no planned maintenance. Thanks to the collection of research on the tools implemented in some companies, the great value of the Total Productive Maintenance methodology can be seen. Factors to consider when evaluating a manufacturing industry are the quality of the products and the efficiency of the machines and the efficiency of the machines. Maintenance management has a noticeable influence on these two factors. Likewise, the participation of the human factor in maintenance practices is essential in the plastics industry [3]. Approximately 30% of the total cost of production corresponds to the development of maintenance activities. [4] The maintenance area plays a fundamental role in providing continuous production of the equipment in its normal operating condition.

Many industries strive to implement these tools in their production processes in order to make them more efficient and more productive. Factors to consider when evaluating a manufacturing industry are the quality of the products and the efficiency of the machines and the efficiency of the machines. Maintenance management has a noticeable influence on these two factors.

2 Estate of the Art

2.1 Maintenance Management Models in Plastics Industries

The industries dedicated to the processing of the plastic item day by day fight against the problems that arise in their production processes, for which they are forced to resort to tools that solve their problems, of which many opt for the implementation of models. of maintenance management that involve various tools [1, 2, 5, 6]. Machine maintenance is a key resource in the plastics industries [2] due to its high importance since more than 90% of the processes are carried out by machines, which are essential for production. The impact of unplanned machine shutdowns during production is significant [1, 2] and this generates large losses, therefore authors [1–3] and [5] opt for the implementation of maintenance models in which they focus on the preservation of the machines. Among the most widely implemented tools is the TPM and its 8 pillars [3, 5] due to their great contributions in productivity, efficiency, effectiveness by increasing the availability of the machines.

2.2 Planned Maintenance for the Plastics Industry

The proposed solution model for the present work is shown in the figure. The solution model consists of three stages of preparation, implementation, and follow-up. Next, the proposed model will be developed.

In the preparation stage, it aims to sensitize those involved about the problem that the company is afflicting; as well as, it is important to have the support of senior management during implementation to achieve effective results [7, 8]. For this, at this stage it consists of different activities such as: The creation of teams that will be part of the TPM committee, the promotional campaign of the project, among others. The activities carried out in the preparation stage are shown below in the figure.

3 Input

3.1 Maintenance Management

During the review of the research literature, different scientific articles have been compiled on the Total Productive Maintenance (TPM) and 5s tools. According to various authors, the use of a Lean methodology technique has the ability to solve any type of problem. The contribution of this research work consists of the combination of two representative tools in order to obtain the results immediately, based on seeking to transform the mentality of the workers in the development of continuous improvement. The proposal model is based according to the authors Kotter and AIDKAR.

3.2 Implementation of Maintenance Management in the Industry

The proposed solution model for the present work is shown in the Fig. 1.

The solution model consists of three stages of preparation, implementation, and follow-up. Next, the proposed model will be developed.

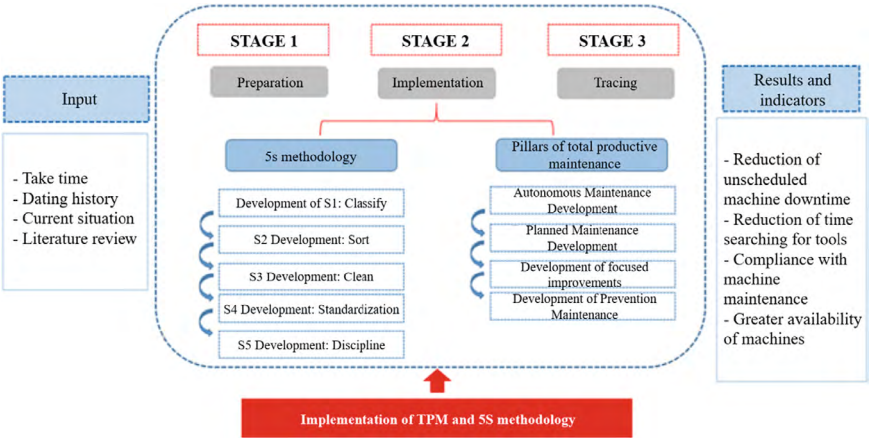


Fig. 1. Proposed model

STAGE 1. In the preparation stage, it aims to sensitize those involved about the problem that the company is afflicting; as well as, it is important to have the support of senior

management during implementation to achieve effective results [5] For this, at this stage it consists of different activities such as: The creation of teams that will be part of the TPM committee, the project's promotional campaign, among others. The activities carried out in the preparation stage are shown below in the figure.

STAGE 2: In the implementation stage, it consists of the development of the 5S methodology as well as the TPM (Total Productive Maintenance). It should be noted that, according to the root causes of the low availability problem, the pillars of autonomous maintenance, planned maintenance and focused improvements will be developed.

In the implementation stage, the 5S methodology will be developed as the basis for the pillars of the TPM. The steps to be carried out in the implementation of the 5s are shown in the figure (Fig. 2).

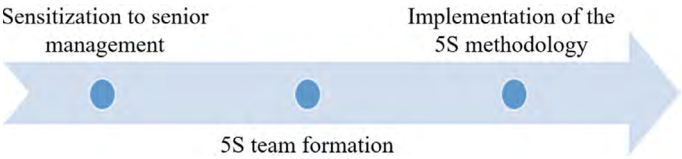


Fig. 2. Implementation of the 5S methodology

In the first step of awareness, it aims to sensitize those involved. Then, the 5S work teams will be formed where each work team has specific functions. Finally, the implementation of the 5S methodology will be developed, the implementation of which will be explained in the figure (Fig. 3).



Fig. 3. Implementation development

For the development of the 5S it consists of the steps of: Classify, order, clean, standardize and discipline.

First, in **CLASSIFY** the necessary elements will be identified by means of a format that will allow them to classify the necessary tools according to their use to place it in a list tools officer. The necessary tools and spare parts are separated according to their need. Finally, there is the process of labeling the items, which will be used by the colored cards.

In **ORDER**, you have the purpose of properly tracking tools and spare parts. For this, a specific place must be established for each element. In this stage, a signaling of tools

that reduce tool search time. As well as, the design of a shelf will be made to separate the necessary elements according to the frequency of use.

In **LIMPIAR**, cleaning schedules are established in the three work shifts, where workers will have the responsibility of keeping their work area orderly and clean. For this, a weekly schedule has been made for each work area.

In **STANDARDIZING**, the purpose is that the first S become habits; For this, it is necessary to create a constant evaluation and training procedure.

Finally, the last step, which is **DISCIPLINE**, will be hanging posters that promote cleanliness and order. As well as, audits will be carried out in order to propose improvement actions, among others.

Likewise, in the implementation stage, the implementation of the TPM methodology will be developed. According to the causes, the autonomous maintenance pillars, planned and focused improvements were implemented.

Autonomous Maintenance. Aims to get operators to commit and take responsibility for their work area through training.

For the development of autonomous maintenance, the following steps have been developed:

- As a first step, it is the training plan for the operators that lasts for one month.
- A cleaning is carried out where it is necessary to record the anomalies presented during the process.
- Then, the key parts of the machines are identified in order to keep them clean.
- Establish a cleaning and lubrication schedule for the machines, where the operators are responsible for cleaning.
- In the general inspection, it is intended that each operator has the ability to detect any anomaly. To do this, he will record it in the monitoring format in order to reduce repair time.
- In the autonomous inspection, the operator supervises the proper functioning of the machines.

Preventive Maintenance. Unscheduled machine shutdowns are caused by lack of planned maintenance in order to reduce operating costs. Currently, the company has a preventive maintenance plan. Planned maintenance in pelletizing machines is important, to avoid constant jams, thus reducing the number of unscheduled machine stops.

Focused Improvement. This pillar is important to solve problems that are not visible in order to make decisions that reduce the number of hours of machine downtime.

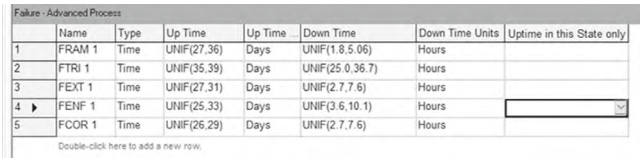
Diagnosis of the problem. To diagnose the problem, the 5 Why? Tool will be used to identify the root cause and be able to solve it.

STAGE 3: Finally, in the follow-up stage, the indicators of the improved production line will be compared.

4 Validation

For the validation of the solution model of the TPM and 5S implementation, a simulation was performed using the Arena Rockwell software. The simulation was carried out with the collection of related data from 4 pelletizing machines. The company under study conforms its production processes as follows. In the first place there is the ramp machine which is in charge of lifting the plastic to the next process, in second place is the shredding machine, which is in charge of transforming the PVC tapes into smaller pieces, in the 3rd place is the extruder already that by means of a screw at high temperatures this melts the material, in fourth place is the cooler which uses the water to solidify the newly melted PVC filaments, Finally there is the cutting machine which is in charge of chopping the solid filaments to transform them into plastic pellets. The simulation was carried out for one year.

To calculate the availability of the machines, a maintenance record has been taken into account, which is related to the MTBF and MTTR (Fig. 4).


Failure - Advanced Process

	Name	Type	Up Time	Up Time ...	Down Time	Down Time Units	Uptime in this State only
1	FRAM 1	Time	UNIF(27,36)	Days	UNIF(1.8,5.06)	Hours	
2	FTRI 1	Time	UNIF(35,39)	Days	UNIF(25.0,36.7)	Hours	
3	FEXT 1	Time	UNIF(27,31)	Days	UNIF(2.7,7.6)	Hours	
4	FENF 1	Time	UNIF(25,33)	Days	UNIF(3.6,10.1)	Hours	
5	FCOR 1	Time	UNIF(26,29)	Days	UNIF(2.7,7.6)	Hours	

Double-click here to add a new row.

Fig. 4. Maintenance record

Likewise, the same procedure was carried out for the different production lines. As a result, we obtained the following table in which we can see the significant improvement in terms of the reduction of hours lost, in the first year a reduction of 39.6% was obtained and for the second year a reduction of 57.4% was obtained % (Table 1).

Table 1. Results

	Line 1	Line 2	Line 3	Line 4	Lost in soles by stops	%Var
Current scenario 1	101	99	123	400	S/. 578,877.17	100.0%
1st year scenario 2	61	63	76	238	S/. 349,508.22	39.6%
2st year scenario 3	38	46	57	168	S/. 246,447.00	57.4%

5 Conclusions

To improve the availability of the machines in the pelletizing area, the implementation of the TPM and 5S should be adopted. When implementing, it was possible to improve the availability of the machines, another parameter that was improved is the performance and the quality rate.

- It can be seen that in 2018 there was an availability of 71% and after implementing the TPM and 5S it increased by 13%.
- It can be seen that the time between failures in 2018 was 28 days and with the implementation an MTBF of 47 days was obtained, which was an increase of 40.43%.
- Another indicator that was improved with the implementation is that of OEE, where it improved by 14.20%.
- With the implementation of the TPM and 5S, the MTTR indicator was improved by 58.51% and the space of the area increased by 176 m.

In conclusion, with this the effectiveness of the TPM can be validated when obtaining the improvement results, the availability of the machine is the most significant.

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GemForest: A User-Friendly Generative Design System for Customization in Jewelry Industry

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Abstract. With the innovation of supply chain, customization services in jewelry industry are thriving. Various online platforms enable users to cooperate with designers to create personalized jewelry works. Considering that normal users are not professional in 3D modeling, the actual design is conducted by others to a large extent. As a result, there is still a wide gap between users and the creative process. To solve this problem, the GemForest system is introduced in the paper, offering a more efficient and inclusive way for users to generate digital models ready for 3D printing. Combining Snowflake algorithm with Fourier transform, the system is able to automatically produce diverse geometric patterns for jewelry manufacture. Through case study, design process and usability test, we provide reference for designers dedicated to the relevant field and discuss future research directions.

Keywords: User-centered design · Jewelry industry · Customization · Design system · Generative design

1 Introduction

With the improvement of industrial productivity, the capacity gradually exceeds the demands and customers have more choices for purchase. As a result, companies are paying more attention to creating featured items so as to target potential users. User-centered design is commonly utilized to understand customers as a starting point for product development [1]. Nowadays, customers' demands in product experience consist of pragmatic and hedonic aspects [2] so that both tangible values and intangible values (e.g. brand and service) are of vital importance. Therefore, providing consumers with qualified products as well as satisfactory experience is the new focus. When it comes to the jewelry industry, that trend is shown as the thriving customization service. Since modern jewelry industry has developed for several decades, jewelry customization enjoys appropriate pricing, high average standard and rising popularity. However, inconvenience and inflexibility in customization services still exist and influence the overall user experience. Traditional jewelry customization is a multi-stage process: (i) users initiate ideas, (ii) designers create digital models, (iii) suppliers provide materials and (iv) factories help to manufacture the products. As a relatively long cycle, it requires many times of information convey among different members, adding to the possibility

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 417–422, 2022.
https://doi.org/10.1007/978-3-030-85540-6_54

of misunderstanding. Besides, normal users are not skilled in using professional 3D modeling software, thus having limited control over the design effect. In other words, there is still a wide gap between users and the creative process, which remains to be solved.

In the information age, users are not only the receivers of information, but also the producers [3]. Through the use of mobile phones, computers and other devices, customers can easily process and produce digital content. Combined with 3D printing, the virtual models created by users can be transformed into physical models. These advances in technology bring about a new form of customization service [4]. In this paper, we propose a system that can efficiently provide design assistance for normal users to generate models ready for 3D printing. Applying the generative design concept, the system enables customers to create jewelry design of various styles such as geometric and bionic.

2 Related Work

With the rise of computer-aided design, designers are able to choose parametric design [5] or generative design other than manual modeling to significantly increase efficiency and creativity. These concepts are also widely applied in jewelry customization systems. Up to now, semi-automatic methods for generating customized jewelry design mainly include shape grammar, evolutionary algorithm [6] and artificial neural network. The existing systems for personal fabrication can be classified according to their accessibility to novices.

The majority of customization systems are designed for professional designers. These systems allow users to freely create shapes by providing a wide range of primary operations. However, users are required to be skilled in using mainstream 3D modeling software (e.g. Rhinoceros and Grasshopper), aware of the rules for graphic transformation to realize their design at ease. For example, the design of 'Corallo' jewelry collection [7] takes customers' body dimensions into consideration and generates organic patterns by sequential steps of transformation. Kielarova and Pradujphongphet [8] proposed a design platform for collaboration in which customers express their design requirements through mobile app, designers modify the design in CAD software and technologists optimize the parameters to obtain printable 3D models [8]. Somlak Wannarumon et.al (2008) developed an aesthetic evolutionary algorithm which can evaluate the quality of generated works and adjust to users' preferences [6]. Kielarova et.al (2013) analyzed the basic shape grammar rules(e.g. translation, rotation, scaling) and builds a generative design system for conceptual design [9]. These applications offer channels for customers to join in the product development but the actual design is still conducted by designers to a large extent.

When it comes to DIY (Do It Yourself) design systems for normal users, Nervous System [10] studies the microscopic cellular structure and provides an online generative design platform for users to regulate parameters and get their ideal effect through simple interactions. Besides, Sketch2Jewelry [11] utilizes sketch-based modeling, thus enabling novices to create complex 3D shapes naturally based on the primitive shapes encoded in the system. Zhang. K (2019) applies genetic algorithm to jewelry design and encourages

customers to interact with the system for preferred solutions [12]. Furthermore, Meshu.io [13] allows users to produce geometric jewelry works from their personal social media data. Data is turned into 2D graphics with special meaning to users through visualization. In these mentioned applications, the simple interaction between human and computers and the automated generative design functions make it possible for common users to customize jewelry design of a certain type.

3 Design Process

According to user-centered design concept [1], we started the design process from understanding users' demands. To begin with, a user study of five jewelry customers was conducted. The customers participating in the user interview were invited to talk about their attitude towards jewelry customization services, review their customization experience, describe the works they customized and figure out the aspects that can be improved. The interview showed that: (i) esteem needs and self-actualization needs [14] were the main drive for choosing jewelry customization, (ii) the current services were time-consuming and required the users to communicate with the designers for several times, (iii) some of the final products received were slightly different from users' expectation (e.g. in the accuracy of shapes, the quality of surface process), and (iv) the efficiency, flexibility and interactivity of current workflow need to be improved to arouse more positive emotions. It can be summarized that simplification of the services (reducing time cost) and enrichment of users' abilities (providing more benefits) are the potential directions for innovation. Besides, the status and trend of related technology (e.g. generative design and artificial intelligence) were researched as well to initiate solutions. Based on users' demands and the technical conditions, we defined the aim of design to be assisting normal users to personalize jewelry design directly. Then three scenarios were built to simulate practical use cases and corresponding state machine analyses were conducted. In the conceptual design stage, wireframes were sketched and the layouts of the pages were decided. After details of the user interface (e.g. fonts, color boards and icons) were added and technical implementation (with Processing.js) was completed, the high-fidelity prototype was created. To verify its usability, we set three basic tasks and checked whether target users could smoothly interact with the system. In addition, the user interface of prototype was evaluated by experts (from School of Design, Shanghai Jiao Tong University) to collect suggestions for future iterations.

4 GemForest System

The purpose of GemForest system is to simplify the jewelry mass customization process. With the system, normal users are able to generate distinctive digital models ready for 3D printing and experience pleasure in DIY activities. The system is developed based on Processing.js so that it can be accessed via browsers.



Fig. 1. Interface of the prototype

The core function of the system is to generate 3D model, and the additional functions are to edit the design and watch others' works in the forum (Fig. 1). The algorithms in the system for generative design consist of Snowflake algorithm and Fourier transform. Combination of these algorithms produces organic and geometric patterns for manufacture. Users can get the model automatically generated by the system by clicking the generate button. At present, two types of pattern are included. Fourier transform and Snowflake algorithm are used respectively in type one and type two (Fig. 2). In type one, users can draw primary components through nesting and compounding of sine as well as cosine functions, and apply graphic transformations (e.g. rotation and scaling) to create patterns with rich details and balanced compositions. In type two, users can define the primitive shapes and transformation rules [9] for each step by regulating the parameters in L-System [15]. The geometric and fractal structures generated through iterations resemble the growth pattern of plants and crystals.

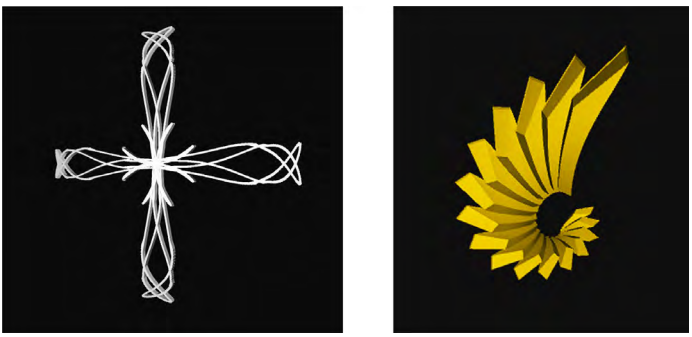


Fig. 2. Left picture: A generated 3D model of type one. Right picture: A generated 3D model of type two.

The editing function enables users to modify the design and get a variety of graphic effects by adjusting the parameters. The adjustable parameters include rotation angle, the sizes of units (scale, length and width), and the colors of units. Users can vary these parameters by pressing the buttons on the editing page to customize satisfactory design. Besides, users are able to rotate the object through mouse movement to view the 3D model from different angles. After completing pleasant works, users can click the download button to download the dwf file to the computer for 3D printing and manufacture. Users are also able to click the upload button to upload their personalized designs to the forum for communications.

The open-source design forum enables users to exhibit their customized designs and appreciate the designs of other users to promote the exchange of inspiration and cultivate a friendly platform atmosphere.

In general, the system is accessible to normal users and extends their design abilities. The art styles of works generated by the system open up new possibilities for creative thinking. Finally, users are connected within the forum so that collaborative design can be an alternative for future update.

5 Results

Based on the guide of user research [16], usability tests and expert interviews were performed. The aim of the tests was to evaluate the design of user interface, users' acceptance of the generated jewelry works and their willingness to use the system. The usability tests were participated by five target users capable of using electronic devices and interested in jewelry customization services. Three basic tasks (generating models, regulating parameters of generated works and visiting the forum) were set to check the accessibility of the interface. The result showed that those basic operations can be completed in a given time. Comments on the generated 3D models of type one included unique, elaborate and attractive while those of type two were modern and bionic. Participators of the usability tests were generally satisfied with the system due to ease of use, interactive DIY experience and aesthetic value of the works. In addition, the user interface was evaluated by experts (from School of Design, Shanghai Jiao Tong University) to check its compliance with design principles [17]. The result showed that: (i) the system was flexible to use and responsive, (ii) the icons were basically recognizable and conveyed their functions clearly, and (iii) there was consistency within components in color, size and shape. At the same time, several suggestions on interface design were also put forward: (i) the rendering speed need to be improved for a smoother interaction and (ii) essential guidance ought to be provided for starters. The evaluations conducted verified the usability and pleasant user experience of the system.

6 Conclusions

In this paper, a user-friendly design system for jewelry generation is proposed. The GemForest system enables normal users to create jewelry works themselves, which improves the efficiency and enjoyment of mass customization services. Through case

study on existing generative design systems, design process and evaluation, we provide reference for future designers from relevant disciplines. Future research directions include: (i) improvement on the code for a higher rendering speed, (ii) recognition of users' preference to intelligently design, (iii) aesthetic evaluation of the generated works, (iv) generation of personalized jewelries according to usage data in the system and (v) introduction of various art styles for generation.

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What Can Linguistics Do to Technology Design?

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Abstract. Intelligent technologies have already revolutionized the economy, and they will continue to do so via autonomous, AI-based systems and artefacts. Artefacts can handle much more intellectually complicated tasks than was possible before. However, the technological transformation will set new demands for technology design and designers. Designing electromechanical technologies has been based on natural science, but intelligent technologies will extensively use knowledge of human research and information processing to create new artefacts. Intelligent information processing has so far been possible only for biological systems and especially for human minds. Therefore, their functions and behaviors will become essential both for the development of new technologies and for the technologies themselves. In this paper, we concentrate on the foundations of investigating how language and thought interact in design thinking. To illustrate the importance of interaction, we present three examples of phenomena in which design thinking and design language meet: explication, understanding, and linguistic (conceptual) change. Understanding how language and thinking are linked within these phenomena may improve the design processes and, e.g., how to train designers' domain-specific skills.

Keywords: Intelligent technologies · Design research · Thinking · Language

1 Introduction

Our age is marked by a paradigm shift between two technologies. The old age was based on electromechanical technologies such as trains, cars, electric motors and lamps. Even early computers can be included in electromechanical technologies. While our society remains dependent on the old technologies, we are simultenously facing an upsurge with an upsurge of intelligent technologies, such as robots, autonomous systems, or GAI, while our society remains dependent on the old technologies [1, 2]. The new technologies can carry out tasks that traditionally have relied on human intelligence [3].

Intelligent technologies will essentially change how people carry out tasks in their everyday lives. The distribution of labor in both the professional and private spheres will be redesigned, and intelligent technologies will replace people in many areas of life. The development that has started in industrial production will expand to logistics and even to areas of high expertise such as medicine and banking. Business management shall rely extensively on autonomous big data analytics to perform their tasks better in the future.

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 423–430, 2022.
https://doi.org/10.1007/978-3-030-85540-6_55

Intelligent technologies will also necessitate human participation in tasks that simply did not exist before. For instance, in medicine it is possible to analyze not only genetic but also environmental data to understand illnesses [1].

Developing an intelligent technological society will require new types of design and development thinking. Electromechanical technologies were mainly designed to aid people in tasks that required mechanical power. Trains were to make moving from one place to another more efficient than animal-based transportation or travel by foot. Cranes were developed to move loads from one spot to another, thus replacing energy-consuming labor by hand. All such technologies were developed to improve human physical capacities; for this reason, it is logical that technical artefacts are designed using our knowledge of physical nature and its forces. The influence of these technologies on human life was extensive, but creating them mainly required in-depth knowledge about mathematics and natural sciences. It was common to see engineering design as applying the laws of natural science to create mechanical artefacts.

The mechanical notion of engineering, however, is hardly valid with intelligent technologies. The focus of technology design will move to intelligent information processing instead of focusing on physical power or speed of operations. The new technologies are designed to support human intelligent information processing or to autonomously carry out this task by themselves. In other words, intelligent technologies are designed to carry out intellectual operations such as categorization, inference, decision making, problem solving and generation of various types of representation. This makes it essential to study how cognitive science, or the science of human information processing, can best be used in designing new intelligent technologies.

Designing electromechanical technologies is based on the laws of nature, but intelligent information processing is a human issue. Only biological creatures have the capacity for some types of intelligence so far. This is why animal, and especially, human information processing form the basis of modern intelligent technologies.

Moving the focus of design processes and the natural sciences to human research and intelligence makes it logical to ask how the achievements of human research could be utilized in design science. One of the many questions is how linguistics could be applied to investigate design processes. Here, we shall outline some central functions of language in design processes and discuss how the study of these touching points between language and thinking may result in an ability of solving innovation, design and development problems more efficiently. We will discuss, how the emergence of new, intelligent technology and its adaption on the societal level makes this contribution of language and linguistics more relevant than ever.

2 Language, Thought and Design

Design is a versatile term [4]. Here, we investigate design by concentrating on the design process as information processing and thinking. We focus our attention on design processes and designers' thinking and consider the role of language in them from a conceptual viewpoint. The core issue is to formulate the research problem and analyze how language and thinking interact in design processes.

Language and thought are intimately linked in human information processing. They are characteristically human traits, but this does not mean that nothing of the kind could

be found in animals. Dogs can understand the meanings of hundreds of commands, and chimpanzees can have insights [5]. However, only people are able to construct huge networks of signs and thoughts. The human capacity to construct and integrate ideas has made it possible for people to develop technologies and to evolve culturally. Thus, the constructive interaction of language and thought has enabled modern human life. The importance of interaction between language and thinking in human creative actions makes it logical to ask what role this interaction could have in designing intelligent technologies.

The human constructive capacity is incarnated in technology design, development and innovation processes. Design is the form of human thinking that makes it possible for people to construct new technologically and socially effective technologies [4]. Development is an industrial process of turning design ideas into products. Finally, innovation extends the thinking outside the walls of industry: Innovation is made possible by the clients of users who adopt new products [6]. The three processes together enable the construction of intelligent technologies and intelligent society, respectively.

Intelligent technologies are an emerging area [1, 2]. It, too, is dependent on the human cooperative capability present in design, development and innovation. When investigating design thinking and language, it is important to assume a wider semiotic perspective, for design practices typically involve various (e.g. mathematical and visual) types of representation in conjunction with natural languages. The function of language in these processes is to allow the presentation and development of conceptual contents along with other representation formats. The main thing is that there is a system of signs that can express thoughts [7].

Thinking is traditionally defined as a mental – and psychological – process that emerges when people have an action goal but no means to reach the goal [8]. A concrete goal requires concrete means, i.e., a practical solution, but first this solution needs to be developed in one's mind. A minute before finding the solution, people may be puzzled and unable to represent the situation effectively, but a moment after they find one, they can represent all the information elements of a path leading to the goal [8]. After finding the solution, people can also express it symbolically so that it can be assessed and specified further.

People must constantly change the information contents of their mental representations when engaging in thinking processes in development work [8]. The changes in mental representations during thought processes have been interpreted in cognitive science as symbol manipulation [8]. Representations are expressed in the human mind as a system of mental symbols, for example, in the symbols of a mental "language" or a mentalese [9]. Transformation means that the systems of symbols forming an initial representation are manipulated into another representation with another system of symbols [10, 11].

Thinking in design processes are described in design research as how internal representations change from one state to another. The function of language is to give expression to the internal representation. Language externalizes the internal representations [7, 9]. Language makes the information contents of mental representations conscious for thinking individuals and the groups or design teams.

3 Individuals and Teams in Design Processes

The Apple Operating System (OS) has around 8.7 million lines of code. If each line had needed one thought, which is a very rough estimate, it would mean that the operating system had needed tens of millions of thoughts or ideas to be created. This informal example illustrates the scope of innovative and integrative work required by a single intelligent technological product.

Thinking is individual in the sense that only individuals can create new thoughts, although the contents of a new thought are usually gathered via numerous social interactions. Thinking is a psychological process in which each thought occurs in one individual's mind. Thoughts themselves do not have a scale. They may concern a one-minute sequence in a code or the overall architecture of an intelligent artefact.

Design thinking is also intersubjective, however, and there are reasons to ask whether even cognition is distributed to some extent. On the one hand, team work involves socialization of ideas that originate in individual minds. When engaged in collaborative design thinking, people think the thoughts originally thought by someone else, challenge them, combine them and develop them further. On the other hand, team work involves accumulation of ideas that the collaborating individuals need to grasp so that the current stage of processing may lead to the next one. In other words, group work can only generate new ideas as a synthesis of individual thought processes. Teamwork makes it possible for designers to integrate numerous individual insights into a complex whole. A team has also an ability to direct individual efforts by defining goals and tasks, such as a place for a line of code or a conceptual architecture of an intelligent program. Teams can also create usages, practices and social organizations around new technologies.

Here, the word *team* refers to any group of individuals involved in developing some intelligent technology. Team refers not only to people directly involved in designing some product but also to people who have created the possibilities to develop such technologies. Thus, as odd as it may sound, Alan Turing (1912–1954) is present as a tacit member of any team working with intelligent technologies [12, 13].

Large-scale teamwork also makes it possible to integrate different types of expertise into holistic design processes. Combining the ideas of numerous people makes it possible to integrate nanotechnologies with mathematics and programming as well as social and organizational researchers. Thus, human research will find its place in the transformation from electromechanical- to intelligent technology-dominated societies.

Human thinking and communication thus enable people to construct intelligent products together. They enable human designers to define the problems, distribute them and solve them. Human constructive thinking makes it possible to create complex representations and the respective technologies or social practices [8, 11]. The constructed ideas can be a creation of one single person, or they may result from social communication. Thus, language is central in design thinking in both the individual and social senses. Language is the indispensable component in individual thinking and in group thinking, but it has two different functions that correspond to the two distinct sources of new ideas. Language makes it possible for a single person to explicate and to express their thoughts and thus expose them to others' criticism and support. Language makes it possible for a group to share knowledge and ideas in order to construct a larger whole. Both functions are necessary for understanding human design thinking in its entirety.

People who have a new idea have to express it in language for themselves. Thinking people become conscious of their thoughts by means of expressing them in some language. New ideas must be communicated by the means of language when one needs others. Social sharing is possible only when participants have, at least to some extent, a shared understanding and common language.

4 Points of Interaction

The first step in investigating how language and thinking operate during design thinking is to create concepts to cope with the thought-language interaction problems. We can collect empirical examples illustrating the points of interaction to reach the goal. Here, we consider three basic phenomena: explication of ideas, understanding them, and changing the conceptual meanings.

Explication is the process of expressing thoughts in an articulate manner. Explication is manifested by online construal of novel ideas in discourse as well as by the process of establishing new concepts. The latter is naturally interpretable as the institutionalization of the former: inasmuch as the representatives of the given field consider an (explicated) idea worth further exploration, it is soon named, defined and adopted as a part of the discursive practices of that field, such as ICT. A new concept may expressed by expanding the use of a pre-existing term (*constructor*), by forming a compound or other neologism (*binary search*) or altering a pre-existing expression grammatically (*to morph X*) [14]. For instance, the novel use of the transitive verb (a verb that involves an object) *to morph X* involves the core meaning of the older intransitive verb *to morph,* i.e., an observable, smooth change between two stages but one now accompanied by a changed perspective in which the end user of a visual interface may intentionally change the appearance of an object. Explication is accompanied in all cases by efforts to define and describe the new concept's contents. These efforts pertain to establishing shared (although not necessarily agreeable) representations, i.e., converting covert representations into overt ones so that they may be scrutinized for their feasibility.

Understanding refers to the faculty of conceptual comprehension. Understanding is manifested in joint design and engineering processes by its very expression (e.g., interjections and phrases such as *Aha!* and *Now I see!*), but it is present more foundationally present in the interlocutors' capability to continue interaction in a sensible way. This capability, in turn, involves the adoption of new concepts as the basis for the subsequent design and planning efforts. The cumulative process of deriving new ideas from the newly-established ones also has linguistic corollaries outside of the immediate planning discourse. Most notable example is provided by the construction of concepts that derive directly from pre-existing ones, thus elaborating and structuring them but also extending their meaning into new ideas. A prominent pattern of concept formation is the construction of categories around hypernyms (e.g., *node*) and hyponyms (*start node*, *goal node*, *internal node*…), in which the meaning of a hyponym is based simultaneously on the category membership (semantic relation to the hypernym) and the extension of the category to new conceptual meaning (signaled by the attribute, e.g., *internal*). The linguistic corollary of understanding, therefore, involves constitution of new conceptual complexes by utilizing the conceptual meanings present in pre-existing concepts.

The change of a conceptual meaning is prevalent in all areas of language use, but it is particularly prominent, i.e., explicit and fast, in areas of high expertise, such as engineering and science. The meanings of pre-existing concepts evolve as their contents are elaborated by research and technological development. More radically, new innovations are driven by associative reasoning, which involves (metaphorical) mapping of pre-existing concepts from one area of use to another. Sources of metaphor in ICT include, *inter alia*, spatial processes (*clustering*) and concrete objects (*node*) as well as popular culture (*zombie*). Metaphoric use of a term allows an illustrative emphasis of the prominent features of the referent, such as the mechanical, unstoppable spamming action of a hijacked *zombie* computer. The function of metaphoric extension is not restricted to emphatic expression, however. Rather, detection of similarities between two distinct areas allow metaphorical structuring of the target area in terms of the source concept, which involves analogical thinking and constitution of new conceptual contents about the target [15].

The three processes – explication, understanding and the change of conceptual meanings – are essential facets of all design, and they all involve a close interaction between thinking and language. Interestingly, they are also mutually linked, in that they combine to constitute the cyclical aspect of design processes. That is, explication and understanding capture the externalization and internalization of conceptual contents that now allow not only the distribution of information but also the recruitment of multiple cognitions in its accumulation and problem solving. Here, creative application of conceptual structures in terms of metaphoric and other linguistic extensions has a pivotal and instrumental role.

5 Language and Mental Contents

We have previously outlined central aspects of our research interest, particularly the interplay of language and thinking in the design of intelligent technologies. So far, the focus of our research has been to create a conceptual framework for describing how technological concepts are created, how they are understood and how they evolve in design thinking.

Ludwig Wittgenstein argued that the meaning of a word is its use [16]. His expression had a flavor of traditional behaviorism, which was a dominant psychology paradigm in his lifetime. Wittgenstein's formulation only provides an externalist explanation of word meanings. It is possible, however, to give Wittgenstein's famous definition a more holistic reading whereby language use also involves both internalization and externalization of conceptual contents. We may argue that the meanings of words acquire their information contents from the way these words are used, but the contents are also represented in, and altered by, human minds so that their use is affected by intentional and institutional thinking processes, such as those present in technology design and academic research. The explicit change of meanings in design processes is a part of technology design processes; thus, various uses are expressed in defining new concepts, in understanding them and in changing their contents.

All emerging technologies, particularly intelligent technologies, require development of a relevant vocabulary that not only serves to communicate but also to constitute

the emerging referents, i.e., the innovations. Metaphors such as *nodes*, *zombies*, *bugs* or *agents* enable designers to explicate their relevant ideas and to express them to other people, but these metaphors may also have a pivotal role in the very emergence of these ideas. The emerging understanding of the cognitive significance of metaphors and other linguistic patterns points to the feasibility of constituting systematic communicative practices for design teams that make use of various linguistic means to promote innovation.

The examples just cited demonstrate that linguistic analysis can give an idea not only about how thinking is reflected in language but also about the trajectories and evolution of thoughts during design and innovation processes. Learning to understand the role of language in analyzing design thinking can be an important tool when it is used consciously to create new ideas. We have merely demonstrated the viability of this line of thought, yet it makes sense to call attention to this new domain of design analysis. Working with intelligent technologies can especially benefit from reflective development of terminology and communicative practices alike.

We argue, therefore, that the design and development of intelligent technologies may benefit from holistic thinking that places direct focus on the interplay of language and thought as a prerequisite for all design. The complexity of this interplay requires multidisciplinary thinking. The fields of human research, such as psychology, sociology, linguistics or history, all serve to illuminate how human information processing works. Thus, it is of strategic importance to explore how we may incorporate human research understanding into designing intelligent technologies both as autonomous wholes and as parts of larger systems wherein human agents continue to operate. Our present study provides a piece of the huge jigsaw puzzle called designing intelligent technologies.

The emergence of industrialism did not change everything in technology design. It brought machines to the production process, which made cheap mass production possible. Many necessary components of earlier industries remained, such as mining, hunting, agriculture or forestry, and many features of production remained similar with few minor modifications. It appears to be a similar case with the emergence of intelligent technologies.

We have cars for transportation today. Cars will be autonomous in the future and will not need drivers, but they will still be cars. Intelligent technologies do not make these artefacts obsolete; they give new properties to the electromechanical artefacts. Yet, designing intelligent technologies extends the discussion on design to new fields of learning.

Electromechanical design was natural-scientific in its essence, but moving from the natural sciences to information- and communication-related disciplines as the main contributive design discussion is a game changer in design thinking. Deterministic natural laws cannot give us strong foundations for thinking and developing intelligent technologies. Intelligence is a human property, and this must be taken into account when planning a new design culture for creating intelligent artefacts. Information is not a matter of matter – or energy [17].

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User-Centered Design – Evolution of an Interdisciplinary Process Approach Utilizing Empirical Research Methods

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Abstract. Engineers are not usually confronted with empirical research methods during their education. Classical product developers thus lack knowledge and the intuition of what to consider when using methods in user studies. The problem is that user studies therefore miss potential development goals for optimized user-centered product design. To resolve these difficulties, a process approach and an in-depth guide have been developed. They provide knowledge, focused on psychology and social sciences about user studies along the ideally typical history of an empirical study in a structured, compact and comprehensible form. This enables product developers to more effectively and efficiently capture the needs of customers. At the same time, the effort required to implement user studies is reduced, errors are avoided and quality is increased. In the future, the process approach and the guide will be verified and validated.

Keywords: User studies · Engineering research · Human-machine systems · Human-machine interactions · User query

1 Introduction

Due to the increasing competitive pressure in product development, user-centered design can provide a decisive competitive advantage [1]. The competitive advantage is that products are optimized to the user requirements [2, 3]. To be able to do this, for the UCD it is necessary to identify and analyze the user needs [3]. Studies with subjects (user studies) are required for this. This can generate knowledge about user needs. To properly understand the needs of users, investigations with individuals must be organized in such a way as to ensure this. The theory, how user studies are designed, does not belong to classic engineering education. Therefore, it often presents a challenge. Product developers usually have no previous experience with studies in which subjects participate and no experience of what influence the study conduct has on the results of the study

© The Author(s), under exclusive license to Springer Nature Switzerland AG 2022
T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 431–442, 2022.
https://doi.org/10.1007/978-3-030-85540-6_56

and therefore what special attention must be paid to. For engineers which perform user studies this unknowledge in this field can easily lead to errors, high effort, and a reduction in the quality of studies. Without consideration of humans and their influence in studies, significant changes in results [4], and misestimations may occur during studies. Developers are often unaware of this and draw false conclusions from user studies for product development. This may lead to incorrect identification and analysis of user needs and thus to the development of products that do not meet the customer´s core needs. Properly conducted and interpreted user studies lead to more usable products [5]. Traditionally, there is a great deal of knowledge, including methods and experiences of user studies in other disciplines that focus on humans. These areas include psychology and social sciences [6]. This knowledge of other areas of expertise is hardly used in product development. It is useful and necessary for developers to have relevant knowledge for designing effective user studies to perform user studies effective and efficient.

Since product development belongs to engineering sciences and is thus considered an interdisciplinary science, there is nothing to prevent the use of knowledge and methods from other sciences and specialist disciplines [7]. A main reason for the low use of the knowledge of other disciplines is the lack of awareness that this knowledge and experience exists and that product developers could benefit from it. Another important reason is the difficult access to this expertise and methodology for product developers. This is because the available literature is very extensive and extends over different areas of expertise, making it difficult to identify suitable basic literature as a non-expert. The degree of detail of available literature is also often inappropriate, which makes it difficult to identify suitable literature. Specific literature addresses the needs of the product developer with a lot of off-topic information, relevant content is difficult to identify. Non-specific literature can do little to help product developers design, perform and evaluate user studies. On the other hand, access to existing literature is hampered by the large amount of specialized vocabulary in the literature of other sciences, as well as the terminology used inconsistently across the different disciplines and research focus, making the content difficult to understand.

What is lacking is a support that structures, compacts and helps to understand existing knowledge from other areas of expertise that could be useful to the product developer, enabling him to perform user studies more effectively and efficiently. This will allow product designers to develop products which better meet user needs.

In this publication, therefore, the aim is to answer the following research questions:

- Question 1: What knowledge from other disciplines is relevant for user studies in user-centered product development?
- Question 2: What should an assistance look like to provide product developers with knowledge in a structured, compact, and understandable way?

To achieve this, the following approach was applied: Specific problems, typical sources of error, and challenges for user studies in product development were identified by interviews. Subsequently, disciplines that focus on empirical studies with a focus on humans were considered. These were analyzed for solutions to the specific problems, typical sources of error, and challenges previously identified. Solutions proposals have been developed and additional literature content has been added to ensure the quality

and effectiveness of an investigation. This content has been structured, merged, and transferred into a process that supports the developer along with a survey. And finally, the whole process was opened up with the knowledge that was provided: understanding, consistency, detail, and language checked and adapted.

2 Methods

What Knowledge from Other Disciplines is Relevant for User Studies in User-Centered Product Development?
To answer the first question, it was first clarified how user studies currently take place in user-centered product development and what challenges product developers face consciously and unconsciously. It was then possible to infer what knowledge is relevant to solve these difficulties and challenges. To identify specific problems, typical sources of error, and challenges of product developers at user studies, telephone interviews with seven researchers were conducted in user-centered product development. The researchers all had prior experience with user studies. For the interviews, a methodological mix was chosen as the method of data collection to obtain an impression as broad as possible of the experiences of the interviewees. Eid and Diener (2006) recommend multi-modal captures [8]. All conversations were recorded and then used for evaluation. The interviewees were informed about this at the beginning of the interview and asked for their consent. The interview consisted of two parts, a narrative interview at the beginning, and afterwards a guideline interview. In the narrative interview, a qualitative explorative study, the interviewer provides a narrative impulse and lets the interviewee tell in peace. At the end, questions are being asked [9]. The aim was to learn how user studies have been carried out, what experiences existed, and what caused difficulties for the researcher to derive a potential need to improve user studies, both directly and indirectly. The specific call for narrative was: "Please tell me in detail what you are investigating with or about people, how have you dealt with user studies so far, and what are typical challenges for you." The guideline interview is a semi-standardized interview, which consists of punctual questions. These questions were based on previously identified relevant aspects of the subject matter of the investigation, which were contained in an interview guide:

- Experience in user studies
- Difficulties in the investigation
- Use of existing assistance during the investigation process
- Used literature
- Main information on investigation processes
- Wish to help respondents to user studies [9]

These aspects were included in the interview guide in the form of questions. The questions were similarly asked in each interview so that comparability between the interviews could be established. The interview was evaluated by a content analysis using a category system. In this context, upper categories, based on the relevant aspects of the thread interviews, were deduced from the material and subcategories from the

data collected were developed. Thus, the given responses of the guideline interview, as well as the narrative of the narrative call, could be categorized.

After evaluating the interview results, the sciences, which deal with empirical studies of human focus, were analyzed. A literary research has been carried out to determine which areas of expertise and methods provide appropriate knowledge and methods for user studies. Literature hints on the quality, effectiveness and error avoidance of user studies within these areas were collected, analyzed, and understood as a relevant basis for necessary assistance. Following, the collected concrete problems, typical challenges, and frequent sources of error from product developers at user studies were used in the interviews to capture content in areas identified as relevant, which offer appropriate solutions. Topics were collected and supplemented by topics that ensure the quality and effectiveness of user studies. The collected subject areas were edited based on relevant basic literature [9–18].

The basic literature was read in parallel, contents were collected and checked. The content was reviewed for overlap, consistency, technical terms, detail, and relevance to user-centered product development. In this way, every step of the process of a user study was looked at in detail and the knowledge was brought together. In addition, content that had been identified as particularly relevant to user-centered product development for user studies had been included in a higher degree of detail than less relevant topics. Within an iterative process, the selected knowledge was structured, compressed, and linguistically adapted. This knowledge had been sorted in an order in which it was necessary in the investigation process to performed it effectively and with high quality. This allowed for a gradual acquisition of knowledge in parallel with the tasks to be performed for the investigation. In conclusion, the complete knowledge was checked and adjusted for understanding, consistency, the introduction of technical terms, and logical order. In addition, a design concept was developed to facilitate access to content and knowledge-taking.

What Should an Assistance Look Like to Provide Product Developers with Knowledge in a Structured, Compact and Understandable Way?

The answer to the second question was also carried out based on the interview results. This was a targeted examination of the assistance that people had been using to date for user studies, whether they were criticized and what additional help they wanted. On the other hand, there was a literature search. It was considered what assistance was available in the state of the research on user studies that included proposed solutions to the identified challenges and how these were structured [19–28]. The nature of assistance was based on the following question: “How well can the existing support for user studies be transferred to user-centered product development?” This assessment had been able to estimate a direction for the type of assistance. It was supplemented by the requirement to structure, and compactly and understandable present the relevant knowledge and to provide references from the state of research. Hereby, the term “understandable” stands for the reduction or introduction of technical terms from social sciences or psychology is meant, so that it was possible to get into subjects quickly.

3 Results

The interviews conducted had an average of 43 min and a time range of 23–69 min. On a five-level scale (not at all, very little, little, much, and very much needed), 57% of the subjects consider the need for user study support with "very much." Cumulatively, all seven people consider the need for support "something" to "very much." In Table 1, the category: "Types of typical challenges" is listed. It is particularly striking that 86% of the interviewees listeted challenges, which identified as "human challenges" or "research challenges." 71% of the interviewees said that when investigating subjects, they select subjects by availability without pre-defined sampling criteria. 57% of the interviewees said they were aware of the presence of disruptive influences on user studies. They tried to capture or control them in the past, but had no systematic approach to it. Free narratives and responses to the guide interviews were taken into account. Multiple names are possible. The percentage describes how many interviewees mentioned at least one item in this category. The following areas of expertise have been identified from the extensive bibliography of user studies: Medical, psychology, social sciences (sociology included), media and communications (marketing included), sports, economics, and philosophy (anthropology included). The empirical research methods in psychology and social sciences have been identified as the basis beyond the references to methods, quality, effectiveness, and error prevention of user studies. Topics that provide solutions to identified concrete problems, typical challenges, and frequent sources of error from product developers at user studies are shown in Table 1.

Table 1. Identified Typical Challenges of User Studies (**a. Consideration of boundary conditions in the planning phase;** b. Create investigation plan; c. Ethical Guidelines; d. Duty to inform trial participants; e. Selection of subjects; **f. Selection of a suitable research question for a study;** g. Selection of an empirical research method; h. Knowledge about correct performance and evaluation of a research method; i. Generating, formulating and embedding hypotheses and theories; j. Operationalization of variables; **k. Consideration of quality criteria of empirical studies; l. Consideration of confounding variables and confounding factors;** m. Potential influencing factors; **n. Consideration of scale levels;** o. Data analysis and hypothesis testing; p. Interpretation and discussion of results)

Types of typical challenges	Identifying challenges	Identified thematic areas for solution
1: Organizational challenges	71% of interviewees	**a**, b
2: Technical challenges	57% of interviewees	**a**
3: Human Challenges	86% of interviewees	c, d, e
4: Investigation Challenges	86% of interviewees	**f**, g, h, i, j, **k, l**, m, **n**, o, p
5: Personal mistakes	14% of interviewees	m
6: Access to subjects	43% of interviewees	m
7: Effort	29% of interviewees	a

Identified, particularly relevant topics are presented in bold. In addition, the following in-depth content was found relevant, as the interviewees were all concerned with it:

- Data collection focusing on experimental and correlative studies
- Selection and number of subjects to be studied (with determinations)
- Basic data analysis: descriptive and inductive statistics

In response to the second question, a process approach was identified in combination with an in-depth guideline, which provides knowledge in a structured, compact, and comprehensible way. For the development of the process approach (see Fig. 1) and the guide, the identified thematic areas from Table 1 are used.

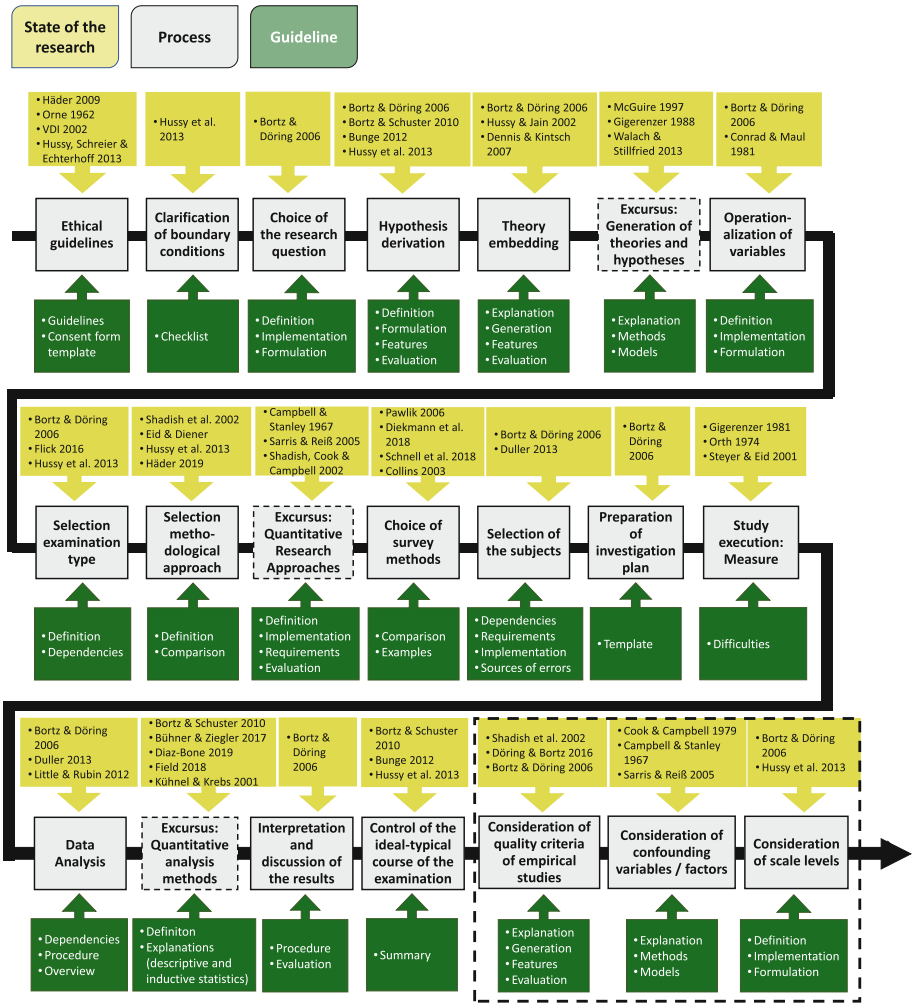


Fig. 1. Process approach (Specifications in the state of the research are listed in the references 29–31, 9, 10, 6, 21, 32–37, 14, 38, 8, 15, 12, 39, 13, 40, 24, 17, 41–49)

The process approach (see Fig. 1) serves to guide and support the design and the entire process of user studies. The dashed box highlights the process steps to be considered during the entire user study. Overall, it accompanies the product developer through the phases of planning, implementation, and evaluation of the empirical user studies. The depth of content with access to concrete knowledge on the topics is provided by the guideline. The often difficult access to literature of other sciences is provided by many literary recommendations within the guide and allows for specific research.

It provides pooled and refined expertise. In addition, language barriers will be reduced and a holistic view of the research process will be promoted through references and consistent technical terms. The guideline is publicly available on the Open Acces platform: KITopen [50].

On the one hand, it is possible to give the developer an overview of the investigation process and guide him/her through its content step by step. On the other hand, the developer is provided with selected, aggregated, and processed content as a source of knowledge. In addition, different levels of detail can also be taken into account here, as well as potential effects of humans as subjects to be reflected in the studies. This combination of knowledge provision and transformation of various specialties, in line with the step by step explanation of the individual process stages of the user studies in the user-centered product development, is a unique feature.

4 Discussion

The problem has been confirmed, that product developers usually have no previous experience with user studies, the possible influence of subjects in studies and therefore what special attention must be paid to. Product developers who have a lot of experience in the field of user studies can acquire the necessary knowledge through a lot of effort.

However, the engineering perspective determines the perception through their education studies, which makes the change of perspective difficult due to bias. In order to save this effort, the already existing methods and knowledge of other sciences can be used. With the following procedure an access was compiled.

Interviews were conducted to identify typical sources of error and challenges in user studies in user-centered product development. Based on this, literary-based solutions were developed, which were structured, compact and intelligible in a process approach and a guide. The research questions were answered:

- Question 1: What knowledge from other disciplines is relevant for user studies in user-centered product development?
- Question 2: What should an assistance look like to provide product developers with knowledge in a structured, compact, and understandable way?

On the one hand, relevant knowledge could be identified by the interview results in the fields of social sciences and psychology. This knowledge consists of expertise and methodological knowledge about user studies with a focus on humans. An example of this are the control techniques of potential disruptive variables in investigations. By using control techniques in a targeted way, disturbing influences on user studies can be

specifically taken into account or eliminated. On the other hand, a process approach and a guideline for deepening could be developed as an appropriate help to provide product developers with knowledge in a structured, compact and comprehensible way.

The process itself gives a guidance on what steps to take within an investigation. The complements to the empirical research process steps by recommended literature from the state of the research and the developed guideline, which details the process steps with reference to literature, offer a possible added value. The product developer shall be progressively made available to him/her in a structured and prepared manner, which is selected chronologically for the examination procedure. In the guide, according to the analyzed typical error sources and challenges of user studies in user-centered product development, different levels of detail are realized in terms of content. This process approach aims to provide a supporting orientation within the User Studies. It is intended to help product designers, especially in the planning phase in combination with the in-depth Guideline, to concentrate on the important contents of the study and to provide suitable step-by-step knowledge for the correct implementation. Thus, a kind of guide for user studies as well as a reference book is provided at the same time.

Limitation and Future Research Needs

The interviews conducted, which are the main source of the selection of topics of the project approach and the guide, are among the qualitative data collection. Data collection is assessed as objective and reliable. The internal validity is considered limited because no weightings were used to consider the typical challenges. The results include the number of people who have addressed challenges in one category. However, whether a subject has identified one or five challenges within a category has not been reflected in the interpretation of the interviews. External validity is considered to be limited because a limited representativeness of the examined sample is assumed. This is because of the group size of the respondents of seven, the choice of subjects based on voluntary behavior and a shared background of the respondents, all working as researchers. Other quality criteria: Procedural documentation, rule-guideness, closeness to the subject, communicative validation are considered to be complied with. The argumentative validation of interpretations as well as the triangulation are rated as complied with a limited extent, since the interpretations of the results were not noted in writing and no further methods were used to compare the results.

In the future, the feasibility of the process approach and the guide, as well as the impact of their use, should be verified and validated. The aim should be to verify the transferability of power of expression to product developers in industry. This has not happened so far. The desired benefits of saving time and effort, avoiding mistakes and improving the quality of the user studies should be analyzed in detail. One possibility for verification is the assessment of the process approach and the guide during and after use in user-centered product development by engineers under field conditions. Both quantitatively and qualitatively, the influence can be divided between the different phases: planning, implementation and evaluation of user studies are considered and examined for structure, content preparation and understanding. The field of empirical studies with subjects into whom user studies are classified is very extensive. The prioritization of content is based on the average needs of the product developer. This was estimated on the basis of the interviews conducted. Individual needs are not taken into account. The basis

for the process approach and the guide is derived from the german-speaking environment. Demographic or cultural differences were not taken into account. Transferability to user studies in the international environment should be considered in future. Differences in ethical and legal guidelines are expected. The process approach in combination with the guide is intended to be an advantage to the state of research, which is to be demonstrated by this. This is because the content is tailored, aggregated and processed to the needs of product developers, so that consistent support is provided during the course of user studies.

5 Conclusion

To remain competitive in the market, user-centered deisgn (UCD) is getting more and more important [1]. For UCD it is necessary to identify and analyze the user needs. But there are difficulties in identifying the real customer needs. Performed user studies often miss their goal to identify the customer's needs. Potential development goals for optimized user-centered product design thus are not achieved. This is because most product developers lack knowledge in the field of empirical investigations for more targeted use of methods, as well as time for familiarization and study performing. It is usually not known which knowledge and which methods are relevant for designing, performing and evaluation of user studies. This easily leads to errors, high expenditure and a reduction in quality of the studies. To prevent this, a process approach was developed. In a summarized and elaborated form, it provides knowledge, focused on psychology and social sciences about user studies along the ideally typical history of an empirical study, adapted to the needs of the product developer in user-centered design. Research-state bibliography complements the process. A guide has been developed along with the process approach to providing the in-depth knowledge needed to conduct user-centric product development studies.

The following procedure was used for the development. First, typical error sources were analyzed in user studies. In addition, interviews were conducted that show that engineers wish support in the field of empirical methods and what typical challenges they face in user studies. In order to identify approaches to support at these challenges, sciences with a high level of expertise and methods in the field of user studies have been identified: Social sciences and psychology. The most relevant knowledge for user-center product development studies has been identified:

- Consideration of boundary conditions in the planning phase
- Selection of a suitable research question for a study
- Consideration of quality criteria of empirical studies
- Consideration of confounding variables and confounding factors
- Consideration of scale levels
- Data collection with focus on experimental and correlative studies
- Selection and number of study participants (with significance for study)
- Basics of data analysis: descriptive and inductive statistics

It is possible to integrate different topics identified as relevant for user-centered product development into a process. A comprehensive bibliography of the relevant subject areas was conducted, content was merged, filtered by overlap and consistency, and checked for relevance to user studies in user-centered product development. This created the process approach. The developed process approach and the guidance it provides must be verified and validated in future studies.

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The Impacts of Covid-19 Pandemic on Online Exam Cheating: A Test of Covid-19 Theoretical Framework

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Abstract. This study empirically examines the theoretical framework model for the relationship between COVID-19, stress, anxiety, and university students' online exam cheating in the USA during the COVID-19 pandemic. The researcher collected primary data of 251 male and female university students in the USA via Survey Monkey and tested the six hypotheses using the structural modeling equation technique. The results validate the significant and positive relationship between COVID-19 quarantine and stress and COVID-19 quarantine and anxiety. The study results show that COVID-19 quarantine causes anxiety and stress among university students, influencing students' behavior to cheat more on online exams. Besides, this study develops a conceptual framework for the relationship between COVID-19, anxiety, stress, and online exam cheating and refines six hypotheses from previously generated propositions. Finally, faculty members and administrators can use the study results as guidelines when thinking and deciding on exams, assignments, and how to monitor online exams.

Keywords: COVID-19 · E-cheating · Stress · Anxiety · Depression

1 Introduction

Cheating on exams is one of the universal academic dishonesty practices among college and university students [1]. Hence, the United States of America (USA) universities and colleges are no exception to the phenomenon of academic dishonesty, including cheating on online exams. Generally speaking, the education culture has increasingly dominated by the need to achieve high grades, besides the pressure to graduate with an honorary degree and acquire a job in an excellent firm pressure [2]. In addition to the pressure on students resulting from many parents' expectations, the recent COVID-19 pandemic quarantine that brought into existence unpredictability for people worldwide has brought forth anxiety and stress. Hence, COVID-19 quarantine is more likely to bring about anomic conditions, resulting in some university students becoming egocentric concerning ethical considerations [26].

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 443–453, 2022.
https://doi.org/10.1007/978-3-030-85540-6_57

This study's primary goal is to examine the impact of COVID-19 pandemic quarantine on college and university students' online exam cheating in the United States of America and develop a conceptual framework for the relationship between COVID-19, stress, anxiety, and online exam cheating among university students. Online exam cheating includes many forms such as using cell phones and social media groups, accessing online exam-related websites during exam time, storing exam-related materials answers on Universal Serial Bus (USB) ports and computers [8].

Few researchers have conducted studies testing the impact of COVID-19 pandemic quarantine on college and university students' levels of stress, depression, and anxiety during online exams and class assignments. For instance, online learning has caused anxiety, depression, and stress from severe to moderate to mild among college and university students [3, 4]. AlAteeq, Aljhani, and AlEesa [5] published a study recently in Saudi Arabia universities on the influence of COVID-19 quarantine students' levels of stress and confirmed a positive and significant correlation between the rise in stress levels among female students and online classes during the COVID-19 pandemic quarantine. Besides, Islam, Barna, Raihan, Khan, and Hossain [6] and Aylie, Mekonen, and Mekuria [7] found that COVID-19 pandemic lockdown resulted in mental health problems among university students, including anxiety, stress, and depression. Perhaps, feelings of helplessness, social isolation, economic fallout, and social distancing can also instigate worry, guilt, frustration, fear, nervousness, loneliness, sadness, and annoyance, which have been found out as factors that impact cheating among college and university students (Marmak & Maline, 1993). The literature review shows that prior studies have found either the correlation between COVID-19 quarantine, anxiety, depression, and stress or confirmed the positive relationship between anxiety and cheating, stress and cheating, and depression and cheating. Nevertheless, prior studies did not recognize COVID-19 quarantine as a critical factor influencing university and college students' e-cheating. Furthermore, prior studies did not explain why COVID-19 quarantine has caused students to cheat more on online exams empirically. Finally, prior studies have developed a theoretical framework for the relationship between COVID-19 quarantine, anxiety, and stress but not a conceptual framework for such a relationship. Hence, this study aims to fill the above-mentioned gaps in the literature by examining the proposed theoretical framework developed by Abdelrahim, Y. [21] to understand whether or not COVID-19 quarantine has contributed to the rise in online exams cheating among university and college students in the USA. This study also develops a conceptual framework for the relationship between COVID-19 quarantine, anxiety, stress, and online exam cheating (see Fig. 1 and Fig. 2). Finally, the study aims to explain why COVID-19 quarantine has caused students to cheat more on online exams empirically.

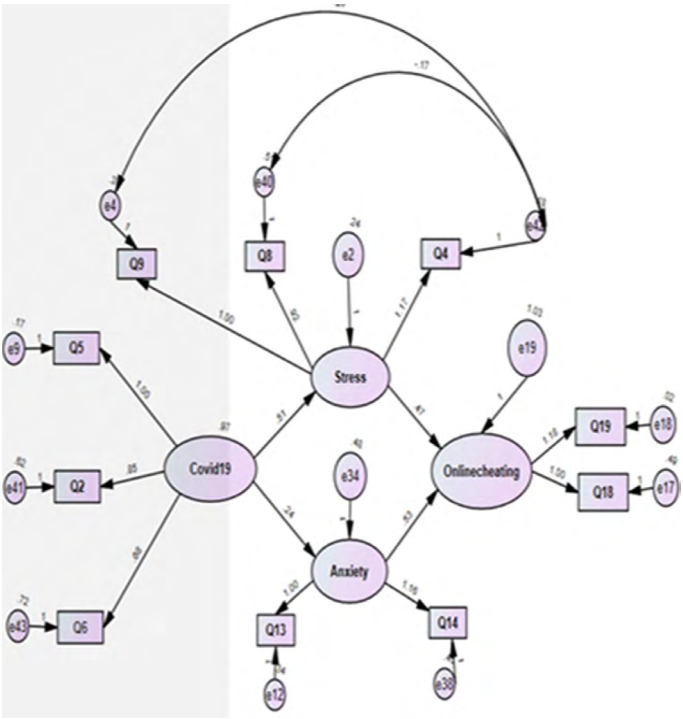


Fig. 1. The conceptual framework for the relationship between COVID-19, anxiety, stress, and E-cheating

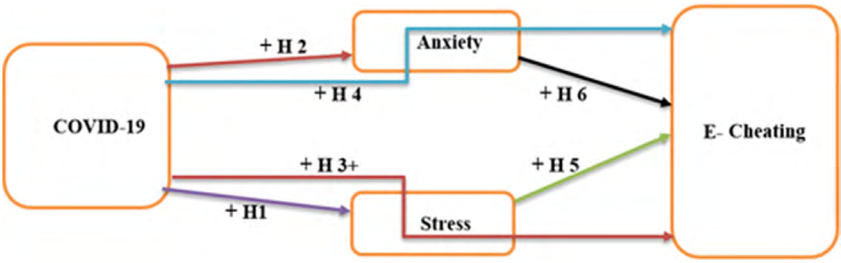


Fig. 2. The conceptual relationship between COVID-19, anxiety, stress and online exam cheating.

These research study findings could help university and college administrators understand why the rise in online exam cheating during COVID-19 quarantine is noticeable and why it is essential to use online exam monitoring cameras and software throughout online exams. The study findings could also help faculty members scrutinize their evaluation practices to reduce stress and anxiety among students throughout the COVID-19 pandemic quarantine. As such, faculty members can address academic dishonesty, anxiety, and stress among students. Faculty members could benefit from this study's results considering the number of exams, assignments, and individual projects assigned

to students during the COVID-19 pandemic quarantine. Besides, colleges and universities need to think carefully about academic integrity in and outside the classrooms to foster a culture of acceptable academic ethical behavior. The study findings could help researchers and educators better understand why online exam cheating is a widespread phenomenon among university students during the COVID-19. Finally, the new conceptual framework could facilitate more quantitative research studies and robust studies throughout the world.

2 Literature Review and Hypo-Theses Development

2.1 Covid-19, Stress, and Anxiety

Anxiety is defined by Brooks and Schweitzer [11] as a "state of distress and physiological perception of emotion or remarkably alert in response to motives, such as the potentiality for unwanted consequences and unusual situations." Hence, anxiety is understood to include stress, nervousness, and fear, which are believed aversive and bothersome emotion [12]. Stress is the body's response to any different, sensitive or physical action that necessitates a response or an adaptation from our body. Stress could develop from any event or thought that causes a person to feel frustrated, nervous, or angry. Stress is a body reaction to new and challenging stimuli that requires substantial effort and determination. In other words, stressful conditions frighten to exceed a single person [13]. Researchers recognized that the earliest depressive events usually generate acute sad life episodes [14]. Besides, stressful life episodes often come before anxiety disorders [15]. I believe that the COVID-19 pandemic lockdown situation is typically stressful, as affirmed by a research study conducted by AlAteeq, Aljhani, and AlEesa [5], amidst male and female Saudi university students.

The COVID-19 pandemic has brought about psychological and emotional suffering and psychological problems such as anxiety, stress, and depression [7]. COVID-19-quarantine associated concerns such as social distancing, social isolation, distress, and economic consequences could also produce psychological mediators, including anger, fear, guilt, annoyance, worry, loneliness, frustration, sadness, nervousness, and feelings of helplessness [9]. The COVID-19 pandemic uneasiness is happening amid many people suffering from everyday mental health issues throughout a catastrophe and even following a crisis [10]. University students are more likely to feel everyday life pressure and additional academic and distress brought by COVID-19 quarantine and uncertainty. Therefore, I expect that COVID-19 pandemic quarantine to have a positive relationship with anxiety and stress and posit hypothesis 1 (H1) a hypothesis 2 (H2):

H1: *There is a positive relationship between COVID-19 quarantine and university students' levels of stress.*

H2: *There is a positive relationship between COVID-19 quarantine and university students' levels of anxiety.*

2.2 Stress, Anxiety, and Exam Cheating

Students' academic lives are stressful due to numerous societal and personal expectations [16]. For instance, the stress created by parents' expectations is the cause of

students' suicide committed each one hour inside India, as announced by the National Crime Records Bureau [17]. There are five different academic stress sources identified by Rajendran and Kaliappan [22], including personal inadequacy, fear of failure, unsuitable study buildings, challenges linked to instructor connections, plus contacts with instructors. Online education, which has been performed globally at colleges and universities as a choice to on-campus teaching, has produced anxiety, stress, and depression among college and university scholars from mild to medium to critical [3, 4]. A recently published research by AlAteeq, Aljhani, and AlEesa [5] on university undergraduates' stress levels throughout COVID-19 quarantine observed a significant positive correlation between high-stress levels and undergraduate female students within virtual classrooms. According to a recent study done by Islam, Barna, Raihan, Khan, Hossain [6], Bangladesh university students have suffered from moderate and severe stress and anxiety due to COVID-19 lockdown. Kouchaki and Desai [18] also found that anxiety is positively related to unethical behavior. As reported by Dienstbier [19] in two different experiments, anxiety and stress have raised female cheating perception. Cultural stress is also identified as a significant predictor of students' common academic unethical behaviors [20]. Accordingly, the anxiety and stress caused by the COVID-19 pandemic quarantine are expected to contribute to students' online exam cheating amongst several university students. Following that brief discussion, I hypothesize the following hypotheses 3 (H3), hypothesis 4 (H4), hypothesis 5 (H5), and hypothesis 6 (H6):

H3: *Covid-19 pandemic quarantine indirectly and positively influences university students' online exam cheating through stress.*

H4: *Covid-19 pandemic quarantine indirectly and positively influences university students' online exam cheating through anxiety.*

H5: *The stress caused by the COVID-19 pandemic quarantine causes university students to cheat more on online exams.*

H6: *The anxiety caused by the COVID-19 pandemic quarantine causes university students to cheat more on online exams.*

3 Methodology

3.1 The Study Sample and Data Collection

The study's primary quantitative datasets were collected using self-administered questionnaire surveys distributed via the Survey Monkey platform. In this research study, the author collected primary data of 251 male and female university students in the USA via Survey Monkey. The Five-Likert-scale questionnaire items range from one (1 = never) to five (5 = Very often). The scale items were borrowed from four different resources. Stress and anxiety were measured by seven items borrowed from the global measure of perceived stress (the PSS) developed by Cohen, Kamarck, and Mermelstein [27]. COVID-19 was measured by six items borrowed from the COV19-QoL scale developed by Repišti, Jovanović, Kuzman, Medved, Jerotić, Ribić, Majstorović, Simoska, Novotni, Milutinović, and Stoilkovska [22]. Finally, cheating was measured by five items borrowed from the academic dishonesty scale developed by Bashir and Bala [29]. The respondents' age ranges from eighteen to twenty-three-year-old, who are

fresh women/freshmen, senior, sophomore, and junior university students in the USA. The respondents spent between three to four minutes answering all the survey questions. The survey response rate was 84%.

3.2 Hypotheses Test

In the first step and before testing the six hypotheses, the author used SPSS 26 software analysis technique to check the scale factor loadings and suggested dimensions. Following the SPSS 26 confirmatory analysis, the factor loadings show that the measurement has four dimensions (i.e., COVID-19, anxiety, stress, and online exam cheating) (see Table 1).

Table 1. The scale factor loadings and dimensions.

Item	Anxiety	E-cheating	Stress	COVID-19
Q7	.733			
Q8	.512			
Q4	.487			
Q9	.457			
Q13		.842		
Q14		.802		
Q11		.796		
Q10		.693		
Q17			-.970	
Q18			-.970	
Q19			-.859	
Q2				-.860
Q3				-.735
Q1				-.702
Q5				-.644
Q6				-.586

In the second step, the author used analysis of a moment structures (AMOS) statistical software analysis in SPSS 26 module for Structural Equation Modeling (SEM) to conduct confirmatory factor analysis (CFA) for the scale items reliability and tested the six hypotheses. The CFA shows that the measurement has four reliable dimensions, including COVID-19, anxiety, stress, and e-cheating. The Cronbach's reliability (α) shows that the scale reliability for the four dimensions exceeds 0.70 (see Table 2).

Table 2. The scale reliability

A Scale Dimension	Cronbach Alpha (α)	Number of Items
Covid-19	0.944	3(Q17, Q18, Q19)
Anxiety	0.830	4(Q10, Q11, Q12, Q13)
Stress	0.821	6 (Q4, Q7, Q8, Q9, Q12, Q15)

The author checked the model fit through the model indices in AMOS graphics results and tested the hypotheses in the last step. The model fit indices show that the author's model fits the data (see Table 3).

Table 3. The model fit indices in AMOS graphics

Index Name	Index Value	Recommended Value/ Acceptable Value
NFI	0.904	NFI >0.90
GFI	0.916	GFI>0.90
RMSEA	0.068	RMSEA<0.08
Chi-Square	27.582	X^2 should be insignificant (i.e., p >0.05)
P-value	0.152	p-value > 0.05 in significant
df	21	

Finally, the regression weights in the AMOS graphics output supported the positive and significant relationships between COVID-19 and anxiety, COVID-19 and stress, anxiety and e-cheating, and stress and e-cheating (see Table 4).

Table 4. The results of hypotheses testing based on the regression weights.

Dimensions	Relationship Direction	Estimate	P- value / Significance		
Covid-19 Vs Anxiety	+ →	0.322	0.034*	<0.05	Significant
Covid-19 Vs Stress	+ →	0.715	0.000***	<0.0001	Significant
Anxiety Vs Cheating	+ →	0.337	0.025*	<0.05	Significant
Stress Vs Cheating	+ →	0.289	0.031*	<0.05	Significant

4 Findings

The results from the regression weights in AMOS show that there is a positive and significant relationship between COVID-19 quarantine and the levels of anxiety among university students (p-value = 0.034, p-value < 0.05). The study results also show that there is a positive and significant relationship between COVID-19 quarantine and the

levels of stress among university students (p-value = 0.000, p-value < 0.0001). These significant relationships between COVID-19 and anxiety and COVID-19 quarantine and stress are consistent with the findings of Aylie, Mekonen, and Mekuria [7], Kecojevic, and Basch, Sullivan, and Davi [4], Fawaz and Samaha [3], AlAteeq, Aljhani, and AlEesa [5]. Stress appears to be a more powerful sign of COVID-19 quarantine than anxiety. In addition, the study results found that there is a positive and significant relationship between anxiety and online exam cheating (p-value = 0.025, p-value < 0.05), and stress and online exam cheating (p-value = 0.31, p-value < 0.05). These results confirm the findings of Kilmer III [20], Dienstbier [19], an Kouchaki and Desai [18].

5 Discussion

Some college and university students noticed that their circumstances had altered dramatically throughout the COVID-19 pandemic quarantine. According to a recent study conducted by Abdelrahim, Y. [21], Students perceived worry of being infected themselves; angry, doubtful about their fate, unfocused, nervous, bored, headaches, isolated, worried, alone, sad, difficulty sleeping, and no desire to eat. As inferred by Taylor, Kuch, Koch, Crockett, and Passey [23], those are feelings of stress. Those anxiety and stress feelings felt by university students throughout COVID-19 pandemic quarantine echo the findings of Kecojevic, and Basch, Sullivan, and Davi [4], AlAteeq, Aljhani, Fawaz and Samaha [3], and AlEesa [5], and Aylie, Mekonen, and Mekuria [7]. Therefore, the positive and significant relationship between COVID-19 pandemic quarantine and anxiety and COVID-19 quarantine and stress is not a surprise but consistent with prior studies.

The significant and positive relationship between anxiety and online exam cheating and stress and online cheating was highly expected to be true for three different reasons. Firstly, in a recent qualitative study done by Abdelrahim, Y. [21], among university students in Bangladesh, many students admitted that they have cheated on online exams due to the stress suffered through COVID-19 quarantine and their worry about their GPAs. Secondly, in three studies conducted by Kouchaki and Desai [18], Kilmer III [20], and Dienstbier [19], the researchers found a positive relationship between anxiety and unethical behavior; anxiety and stress increase female cheating perception. Thirdly, the institutional anomie theory developed by Messner and Rosenfield [24] explains how some cultural values in some societies, such as cultural achievement and conformity, affect individuals' abnormal behavior and eventually bring in specific conditions. The high levels of anxiety and stress throughout COVID-19 quarantine trigger an individual's self-serving ethical rationalizing. Students who underwent high levels of anxiety or anxiety will find themselves have no moral worry or fear about obtaining their personal goals utilizing unethical behavior, in this case, study case online exam cheating.

6 Conclusions

This research study endeavors to quantitatively examine the recently developed theoretical framework model for the relationship between COVID-19 pandemic quarantine, stress, anxiety, and university students' online exam cheating (i.e., e-cheating). The recently developed model fundamentally demonstrates how COVID-19 quarantine

affects university students' levels of anxiety and stress, and therefore, influences the frequency of online exam cheating behavior among college students. The author collected primary data of 251 male and female university students in the USA via Survey Monkey and used the Institutional anomie theory to support the argument. Using the structural modeling equation (SEM) technique, the study results confirm that COVID-19 quarantine has a unique relationship with stress and anxiety. The relationship between COVID-19 quarantine and stress is more significant than the relationship between COVID-19 quarantine and anxiety. The study results also validate the significant and positive relationship between COVID-19 quarantine and stress, COVID-19 quarantine, and anxiety. As, such COVID-19 quarantine causes more anxiety than stress among university students, and therefore, influences students' behavior to cheat more on online exam cheating. Theoretically, this study translates a qualitative research question from a prior study that developed the COVID-19 quarantine theoretical framework into an explicit prediction of anticipated outcomes. This study also developed a conceptual framework (i.e., research paradigm) for the relationship between COVID-19, anxiety, stress, and stress that specifies future research direction. Besides, this study refined the six hypotheses from previously generated propositions. In that context, this study is the first to test the COVID-19 theoretical framework empirically. This research study has developed six testable hypotheses, which opens the door to more future tests and hypotheses regarding university students' ethical behavior, stress, and anxiety.

Those research study conclusions could help college and university administrators agree that using lockdown software and monitoring cameras are crucial throughout online exams. Numerous officials are still unwilling to purchase and execute software programs capable of monitoring online exam dishonesty. The findings could further help teachers examine their evaluation practices to decrease student stress and anxiety through COVID-19 quarantine. Faculty members maintain several choices to evaluate students' achievement during the academic year. They should decrease the number of midterm exams and assignments throughout COVID-19 quarantine to help reduce stress and anxiety among university students, particularly in society.

Furthermore, colleges and universities should reconsider academic sincerity in their programs to produce a society of academically satisfactory ethical behavior. Overcoming anxiety and stress among school students is only one way to curb students' unethical behavior. Educators must understand their role in building the cornerstone for today's students and future business employees and owners.

7 Research Limitations

These study findings are limited to university students in the USA. The researcher surveyed university students for this study in one country via survey monkey thought-out the COVID-19 pandemic. Hence, the influence of COVID-19 quarantine has been narrowed to a single culture in the USA, single society, and age (i.e., eighteen to twenty-three years-old). Surveying students from different cultures might have provided this research study with a deeper perspective on diverse respondents' investigation dilemmas. In other words, the generalizability of the findings could have been better. Future researchers should collect their primary data during the COVID-19 pandemic and investigate these study findings in different countries worldwide.

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Application of Augmented Reality Technology for Age-Friendly Travel

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Abstract. With the rapid development of urbanization, the issue of the construction of an elderly-friendly city has been raised. Due to the deterioration of the mobility and perception abilities of the elderly, it is more difficult to adapt to the urban traffic travel environment, and there is a greater demand for intelligent travel auxiliary products. This paper analyzes the travel characteristics and pain points of the elderly through user experience maps and typical scene analysis, and explores the feasibility of combining AR technology application with aging travel based on sensory compensation theory. This paper takes the two daily travel needs of elderly people, including walking and public transportation, as the starting point, and proposes the design concept of wearable travel assist glasses. It adds new possibilities for the aging of smart cities in the future.

Keywords: Augmented reality · Elderly-oriented design · User demands · Sensory compensation · Humanized design

1 Introduction

1.1 Social Background

WSince the topic of smart travel and the construction of an elderly-friendly city was put forward, the academic community has also paid attention to the problem of aging travel, especially in cities. Due to the deterioration of their physical mobility and perception ability, their ability to adapt to the traffic environment in the city declines, which in turn triggers psychological resistance.

Urban elderly people have a greater demand for smart travel auxiliary products. However, the interaction methods are generally more in line with the habits of young people, and the elderly group is rarely considered [1]. In summary, the lack of human care in the design of modern travel assistance products has formed a digital generation gap between the aging travel and the urban traffic.

1.2 Research Significance

The realization and application of AR technology can assist healthy and mildly disabled elderly people to travel from the perspective of sensory compensation, which helps them adapt to the rapidly developing travel environment at the physical level. At the same

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 454–461, 2022.
https://doi.org/10.1007/978-3-030-85540-6_58

time, aging products adhere to the principle of giving consideration to both emotion and experience to interact, which slowly eliminates their discomfort for high-tech travel at the psychological level.

In summary, this article will deeply study the travel conditions of healthy and mildly disabled elderly people, solve the problems of their discomfort in modern travel, and design smart travel wearable devices based on sensory compensation theory. It provides an innovative perspective for smart travel for the elderly and adapts to future urban development trends.

2 Augmented Reality Technology

2.1 AR Technical Principle

Augmented reality technology is a new 3D technology that seamlessly integrates real world information and virtual world information [2]. It simulates and superimposes entity information (including visual information, sound, taste, touch, etc.) that is difficult to experience in the real world [3]. The real environment and virtual information are superimposed on the same picture or space in real time, so as to achieve a sensory experience beyond reality.

2.2 AR in Smart Travel Navigation

The AR system has real-time interactivity, and it can integrate the real world and virtual information and locate virtual objects in three-dimensional space [4]. Therefore, AR is very suitable for the field of intelligent travel navigation. Various electronic maps based on this technology are becoming mature, such as Apple ARKit, Holomaps, Civil Maps, AutoNavi AR maps, etc. This type of navigation product first captures the actual road conditions through the tracking system, and then performs traffic big data calculations and mobile calculations to obtain navigation decisions. At the same time, image recognition and AR technology can directly present intuitive 3D navigation guidance in real-time on the real road screen.

At present, navigation software under AR technology still has certain limitations. First of all, the driving and travel scenes are mainly considered, but the scenes of public transportation and walking (especially indoor navigation) are ignored, and the guidance level for the last 100 m walk is insufficient. Secondly, although it can provide more realistic navigation effects and more real-time and intuitive prompt information, its interactive experience and information presentation are only communicated through the smart phone screen and voice, which does not actually consider the experience of elderly users.

3 User Research

The elderly user group has a long age range, and there are big differences in lifestyle, cultural background, and economic income. Research on the travel status of elderly users should not only pay attention to their common problems caused by physiological changes and physical function attenuation, but also cannot ignore the close relationship with their urban context.

3.1 Physiological Characteristics

Generally speaking, the elderly are in a healthy and active period between the ages of 60–64, in self-reliance period between the ages of 65–74, in slow behavior period between the age of 75–84, and in caring period over the age of 85 [5]. In terms of health status, 90% of the elderly in China are in good health, 7% are mildly disabled, 2% are moderately disabled, and 1% are severely disabled. This paper chooses urban elderly users between the ages of 65–74 who are in a healthy or mildly disabled state as the research object.

People at this age have great changes in their physiological characteristics, and their physiological functions begin to decline [6]. In visual perception, the color discrimination and eyesight of the elderly gradually decline; in auditory perception, hearing and sound sensitivity gradually lose; in tactile perception, the flexibility and touch sensitivity of limbs decrease. Similarly, the brains of the elderly are not as sensitive as before, and the degeneration of the sense of direction is the key reason that makes them difficult to recognize the road.

3.2 Phychological Characteristics

This type of elderly people tend to have similar psychological characteristics: First, as their physical functions age and their ability to adapt to the environment decreases, they are more likely to develop sub-healthy mental states. Secondly, their unusual appearance and physical shrinkage make them change their personalities and become more emotional. Finally, the inadaptability to the fast-developing society makes most of the elderly feel inferiority and loneliness. In terms of cognition and learning ability, the elderly tend to show a trend of two levels of differentiation. Most of the elderly are not resistant to learning to use new products, but their abilities are insufficient. Only a few elderly people have strong abilities and can use smart products more skillfully.

3.3 Overview of Daily Travel

For healthy and mildly disabled elderly people, short-distance travel is mainly about 3 km within their own living area, and the sense of obstacles caused by the environment is not strong. When it comes to middle-distance travel, most elderly people adapt and rely on traditional public transportation, but unfamiliar routes will make them feel uneasy about travel.

Walking Scene. Demand side: The way of walking is the way that elderly users use most daily. In daily travel, the elderly have the highest demand for walking map navigation. At the same time, the elderly are also easily lost in large indoor scenes such as shopping malls and high-speed railway stations, and rely heavily on pedestrian navigation.

Supply side: Most pedestrian navigation products cannot eliminate the unfamiliarity of elderly users when using the product. The mainstream flat maps are mainly textual information, making it difficult for elderly users to obtain accurate information, such as matching map logos with their own location, identifying directions, and so on. The real-time navigation function is not perfect, the static real-time picture display cannot

correspond correctly to the actual scene, and the poor interactive experience of the click sports lens makes the elderly users discouraged.

Public Transportation Scene. Demand side: The elderly usually choose buses or subways when in middle-distance travel. Since subways and buses have been used as traditional public transportation for several years, the elderly are familiar with them and have good adaptability.

Supply side: At present, almost all public buses and subways are equipped with a voice announcement system, and most bus shelters have a vehicle arrival system. Therefore, the information at the front and end of the travel process is relatively complete, but there are "blind spots" in the transfer information link at the middle end. The guidance information of subways and buses "does their own way" and does not form a unified identification system. At the same time, the dense guidance information is difficult for elderly users to identify.

3.4 Urban Elderly Travel Experience Insights

Based on the perspective of continuous time and space activities, this paper conducts user research through Context Inquiry, Camera-Tracing and other methods (Fig. 1).

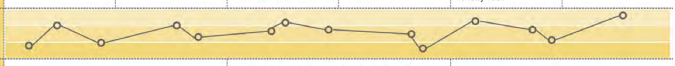
Phase task	Plan route	Walk to the bus station	Take the bus	Transfer to the subway	Enter the shopping mall	Arrive at the destination
Detailed task	1 Plan route, 2 Search for the bus stop, 3 Wait for the bus, 4 Swipe bus card, 5 Take the bus, 6 Get off, 7 Enter the subway station, 8 Security check, 9 Swipe in, 10 Judge the direction, 11 Swipe out, 12 Enter the mall, 13 Locate floor, 14 Arrival					
Target	Get route information	Short-distance walking	Long-distance by bus	Long-distance by subway	Short-distance indoor walking	End the trip
Touch points	• route map • Mobile navigation	• Bus station • information board	• bus • Credit card machine	• Ticket machine • Card machine • Metro guidance	• Store floor layout	• Destination signage
Questions	• How to use navigation software? • How to enter?	• Where is the bus stop? How to go? • Which station is closer to me?	• When will the bus come? • When should I get off?	• Which direction? • Where should I export from?	• Which entrance? • Where to take the elevator? • What floor is it on?	• Is this the destination?
Satisfaction points	Accurate route planning	Familiar bus stations nearby	Convenient card for the elderly	Comfortable ride experience	Reasonable floor zoning	Clear destination sign
Pain Points	Smart navigation operation process is not friendly	Obtaining bus information is difficult	The bus itinerary and arrival reminders are not sufficient, and the elderly are prone to stop by mistake	There are too many types of subway guide information, which is easy for the elderly to miss	The internal environment of the mall is relatively complex and lacks effective navigation, and the elderly are easily lost	Missing reminder that has arrived
Emotion curve						
Chance Point	• Improve input and output methods and add smart roles such as Siri • Increase incentive mechanism after completing travel tasks		• Clarify platform identification, bus information, station location and other information • Comprehensive collection of information on internal three-dimensional environments such as shopping malls (such as the location of elevators, etc.)		• Strengthen functions such as automatic fee deduction, itinerary broadcast, arrival reminder, etc. • Summarize and sort out different types of guide information, and pass it to the elderly through multi-sensory channels	

Fig. 1. Urban elderly travel experience map

The user experience map focuses on the travel modes and behavior preferences of elderly users for walking and public transportation, and captures the behavior touch points and interactions between human, machines and the environment in the service context, so as to establish the travel chain and behavior flow of elderly users.

4 Design Results

4.1 Design Principles

Instinct Level: Before designing intelligent travel assistance products, it is necessary to accurately grasp the primary and secondary needs of elderly users. First of all, according to the habits of the elderly, the product must be easy to carry, such as handheld, wearable, etc. Secondly, when implementing the navigation function, the interface design needs to take into account the recognition and cognitive abilities of the elderly [7] users to achieve the most basic usability goal of the interaction process, that is, the balance between experience and information prompts, information volume and operability, and Information feedback during operation. Finally, GPS navigation and positioning, remote monitoring and emergency call for help functions are very important to the travel activities of the elderly, so the design can be equipped with advanced technology as the core with mobile terminals, which can respond to emergencies while realizing fast navigation services.

Behavior Level: Facing disadvantaged groups, sensory compensation is widely used in product design as an effective design method. It is necessary to fully take care of the physiological changes of the sense organs of the elderly and choose the appropriate human-computer interaction language to ensure the effective transmission of information. For example: in visual perception, reasonably adjust interface layout, text size, image clarity, color resolution and other elements to ensure accurate perception of information; in auditory perception, pay attention to the choice and change of sound frequency to provide effective information Reminders and feedback, alleviate the old people's unfamiliarity with the machine; in terms of tactile perception, avoid the limitations of gestures such as abduction and adduction of the fingers of the elderly, and use multi-point touch or give feedback on operating behaviors, such as sagging icons, vibration, etc.

Reflective Level: In the current advocacy of people-oriented, product design must express human care for the elderly, so that they can realize their self-worth on the basis of meeting the basic needs of knowledge, reduce the inner feeling of emptiness and loneliness, and satisfy perception, Emotional and spiritual needs. For example, the interaction process and method fully consider the life experience and educational background of the elderly, and express it in an elderly-friendly form to reduce cognitive load; the visual expression form incorporates humane elements to satisfy the aesthetic taste of the elderly and help the elderly resolve negative emotions; Set up friendly fault-tolerant methods such as one-key return, warm reminders, etc., to reduce misoperations and avoid helplessness, self-denial or even rejection.

4.2 System Architecture Design

The system architecture design of intelligent auxiliary travel equipment based on user behavior is as follows (Fig. 2):

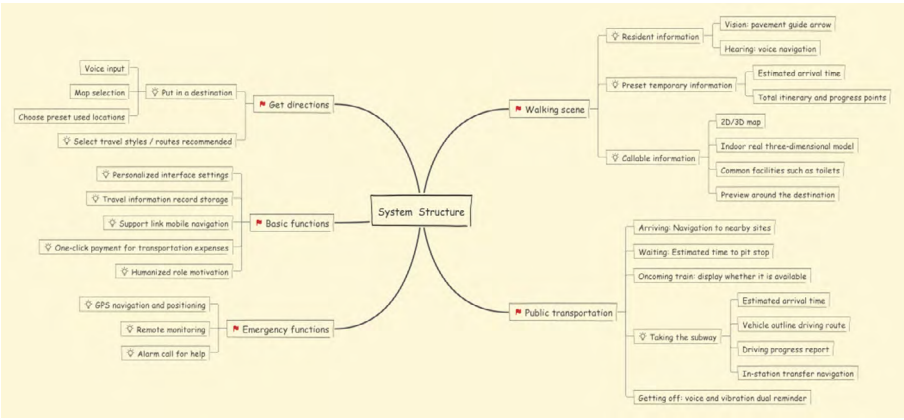


Fig. 2. Product system interaction system framework

Walking Scene: The key to meeting the walking needs of elderly users is to clearly provide the most critical and easy-to-understand information. Therefore, the walking AR navigation mode removes redundant information and only retains the permanent information of the road guidance arrows. Reminder information is displayed intermittently at preset nodes, such as estimated walking time, outline route, etc. The background information needs to be displayed by the user with instructions. Such information includes indoor 3D models, general facility information, destination previews, etc.

Public Transportation: The logic of subway travel is similar to that of bus travel. Taking the bus travel process as an example, it is broken down into three stages: "waiting", "riding" and "getting off". In the first stage, after the product guides the user to the corresponding bus station, it actively displays important information such as the estimated time of arrival of the target vehicle. In the second stage, the product uses traffic big data to mark the target vehicle as green, and the user only needs to distinguish the green-labeled vehicle in the vision to easily ride the vehicle. The third stage is to solve the problem of where to get off the bus. The product provides an estimated time of arrival, and reminds the user to get off at the station two minutes before the stop.

4.3 Product Design

Based on the above design principles and system framework, this paper uses wearable glasses as the carrier to develop the design of smart travel auxiliary products (Figs. 3 and 4).

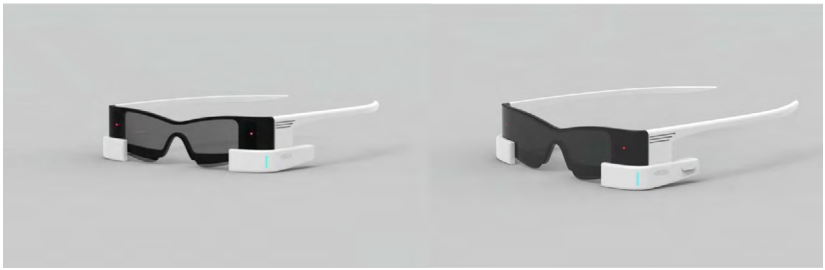


Fig. 3. Smart travel assist glasses renderings

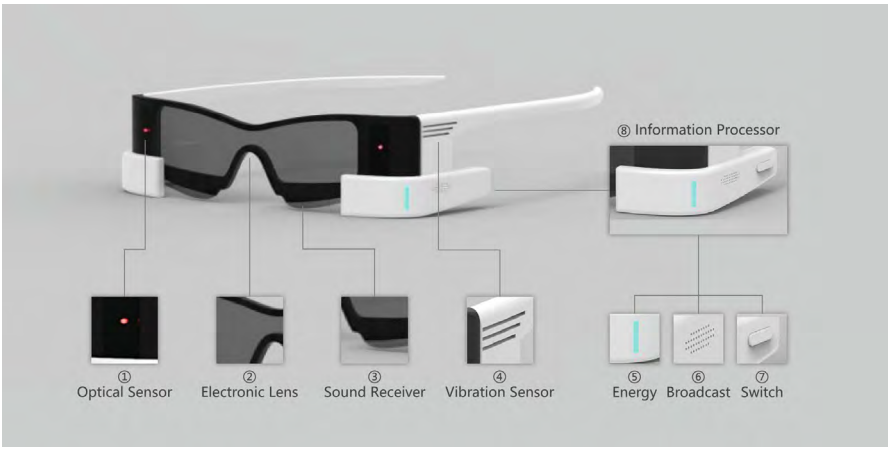


Fig. 4. Smart travel assist glasses structure

At this stage, the computing power in the mobile environment is limited by the processing power and storage capacity of the head-mounted display device. Some complex calculations will be completed on the network side, and then the data stream will be transmitted to the terminal (Table 1).

Table 1. The function of each component of the smart travel auxiliary glasses

Number	Elements	Features
①	Optical Sensor	**Input:** Used to collect user gesture interaction instructions **Monitor:** Collect the movement information of the human body during travel **Tracking System:** Double-sided sensors can reduce the impact of human head swing on information collection
②	Electronic Lens	**Display:** Display the navigation interface superimposed with AR technology; actual road scene recognition; eye tracking
③	Sound Receiver	**Input:** collect and recognize the user's voice instructions

(*continued*)

Table 1. (*continued*)

Number	Elements	Features
④	Vibration Sensor	**Input: T**ouch to call up the alarm emergency interface **Output:** output strong prompt information in the form of vibration
⑤	Energy	**Basics:** display power and equipment operating status
⑥	Broadcast	**Output:** output navigation information in the form of sound
⑦	Switch	**Basics:** Flip up and down to control the switch
⑧	Information Processor	**Information Integration:** receive sensor information through the built-in wireless information receiving and sending device **Mobile Computing:** Calculate real scene information and road navigation with the aid of optical see-through AR system and traffic big data

5 Conclusion

AR technology has huge development potential in the field of aging travel. This paper uses reliable user research methods such as Context Inquiry and Camera-Tracing to gain insights into the travel characteristics of the elderly in daily walking and public transportation travel scenarios. This paper deeply discusses the design principles that sensory compensation theory and emotionalization theory applied to the intelligent travel assist devices for the elderly, and proposes design strategies considering both physical and psychological perspectives. Finally, a set of design prototypes suitable for the elderly based on augmented reality technology has been formed, which adds new possibilities for future smart travel.

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Research Approach for Predicting Body Postures and Musculoskeletal Stress Due to Disruptive Design Changes on Power Tools

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Abstract. Biomechanical simulations can be used to evaluate the human stress during use of existing power tools. However, when the design is disruptively changed, it is challenging to predict the future nature of the user's use, posture, and load. Although simulation environments already exist for body posture prediction, they are not suitable for unbounded motion or postures. In this paper, a multi-level research approach is described. This approach allows the development of application-specific body posture models based on co-simulation in combination with a subject-based study as well as the evaluation of human stress. This enables manufacturers of power tools to make disruptive design changes and evaluate them concerning musculoskeletal stress at an early stage in product development.

Keywords: Humans posture · Posture prediction model · Ergonomics · Biomechanical simulation

1 Introduction

When developing technical systems that involve direct physical interaction between humans and machines, a significant effort must be made to design the system in accordance with the needs and requirements of users (Aptel et al. 2002). These requirements and needs include boundary conditions that have to be taken into account from a health point of view (avoidance of harmful postures (Karhu et al. 1977), vibration emissions (ISO 5349-2; Zimmerman et al. 2017), etc.), but also requirements according to which a system has to be designed to optimize the user's perception during use (vibration perception, stress pain,…). The better the requirements and needs of the user are understood, the better and more targeted user-centered products can be developed (Looze et al. 2001). In practice, however, technical systems are still often insufficiently adapted to these requirements, resulting in significant disadvantages for both the manufacturer and, not least, the user (Vink und Hallbeck 2012). Using the exemplary technical system of power tools, this article points out the lack of user-centered approaches in development and presents possible solutions to improve this current tendency.

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 462–467, 2022.
https://doi.org/10.1007/978-3-030-85540-6_59

The development of power tools is still predominantly carried out from a functional-technical point of view, whereby the arrangement of the operating and guiding elements is aligned with the system components and only follows ergonomic principles to a very limited extent (Vedder und Carey 2005). The possibilities of optimally adapting a system to the user and thus greatly reducing the physical musculoskeletal stresses on the user during use can therefore not be fully exploited based on today's product designs. If, on the other hand, products are to be created with the least possible stress for the user during an application, ergonomic aspects must be taken into account in the product design at a very early stage of product development. To accomplish this, it is necessary to completely rethink the design approaches of power tools. This involves first designing systems according to ergonomic and application-specific aspects and only in a second step aligning the technical components with these specifications. There are many examples of such a lack of ergonomic product design. Such as the pistol grip of hammer drills or cordless screwdrivers, which has remained almost unchanged for decades, the high top-heaviness of drills and hammers, which is always noticeable, the coupling of the battery pack at a distance from the center of gravity in cordless screwdrivers, and many more. The main disadvantages are the high costs and time involved in iteratively adapting such disruptive design changes to the user's requirements. The verification of new design adaptations takes place primarily in field studies, in which prototypes of the new product generation are tested and evaluated by users. The costs for designing and manufacturing such prototypes, which must already be functional and usable in operation are high and for resource reasons often only a limited number of prototypes can be built and examined (Germann et al. 2019). In addition to the effort that has to be invested in the preparation and the actual execution of the tests with subjects is extremely time-consuming and cost-intensive. Furthermore, finding suitable subjects, conducting the experiments, and setting up suitable data acquisition methods is a challenge and requires extensive knowledge (Vink et al. 2002). The data generated in field studies to analyze the subjectively perceived musculoskeletal stress of the user about the prototypes provided are often subject to a high degree of uncertainty since the number of test subjects is usually kept relatively limited for the reasons mentioned above. The interpretation of disruptive, user-centered product generations based on physical prototypes and field tests is therefore very difficult and time-consuming. Accordingly, if more technical systems such as power tools are to be developed for the user in a stress-optimized manner in the future, new methods should be investigated that enable early, cost-effective validation of ergonomic principles. In the current state of research, there are already initial approaches as to how body postures and the resulting musculoskeletal stresses on the user can be simulated based on product and application boundary conditions. Thereby, simulation environments are needed which can predict a realistic body posture of the user with the product in the application, as well as environments that can predict musculoskeletal stress from the given posture and load by external forces.

2 Suitability and Limitations of Current Simulation Approaches

A simulation environment for the prediction of body postures, which is mainly used in the automotive context, offers the model of RAMSIS. The model predicts the posture based

on the probability distributions of empirical joint angles. For given boundary conditions a solution maximizing the probability function for every angle is found. The manikin is then positioned according to these angles. The renunciation of complex computing operations makes RAMSIS a convenient tool for body posture prediction. The down side is the inflexibility of the model. Each posture type (e.g., sitting vs. standing) needs new empirical data to fit the model. To cater to this RAMSIS has a function implanted to individualize the prediction models. So, it is possible to generate a new posture model with a small participant study (Seidl 1994).

RAMSIS also comes with an anthropometric database containing different populations. This allows the user to assemble a virtual test collective and take anthropometric boundaries into account.

The model is currently not suitable for the assessment of power tools as there are only two basic models for standing upright. This might be feasible for working at chest height, but for working overhead and on the floor new models are needed. Even for working on chest height, the model does predict a leaning forward as people would do while drilling.

Beside the simulation of the human's posture during application the simulation of the human stress plays a crucial role during product development. The biomechanical simulation is to be seen as an extension of the instrumental biomechanical analysis. It is applied precisely where no further statements can be made from the instrumental analyses (e.g. joint or muscle forces). Digital human models represent certain human characteristics in the associated application context. In simulations, statements can be made about stress or performance. An extension of the anthropometric models is the biomechanical model. The aim of the biomechanical simulation is the consideration of physical effects in connection with the human musculoskeletal system. Biomechanics can therefore be seen as an interdisciplinary field of research in which, among other things, findings from movement sciences, medicine, health, and occupational science, as well as physics, chemistry, and neurosciences, flow together. Biomechanical questions can be divided into system considerations of kinematics and kinetics to specifically represent certain percentiles of a group of people or body dimensions of a specific person are represented. These musculoskeletal models are often used for performance or stress analyses of the musculoskeletal system in sports, ergonomics, surgical orthopedics, or medical technology.

Biomechanical human models are used, for example, in overhead drilling applications. Here, external forces are imposed on the human model in specific postures to be able to make statements about the acting joint forces and muscle activation processes depending on the postures (Chang et al. 2019). In addition, there are also first approaches of kinematic motion and posture generation. The basic idea here is to predict the movement of the human model by geometric constraints. However, this approach is only suitable for kinematically constrained systems. Moreover, these predicted human motions did not consider external forces.

The challenge in coupling the human models from RAMSIS and OpenSim is to define the appropriate data formats and interfaces to enable co-simulation from the two models. In addition, biomechanical models in OpenSim are created for the respective use case. There are already valid models in the state of research, which can be modeled

very well and used initially for individual body regions such as the shoulder (Saul et al. 2015). For future research work, it may be necessary to adapt the structure and properties of existing models to the respective application.

Examples of software for modeling and simulation are the commercially available AnyBody Modeling System (Rasmussen et al. 2003) and the open source system OpenSim (Delp et al. 2007), which is widely used in research.

Based on the current state of research, it can be stated that simulation environments already exist which offer the prerequisite for taking ergonomic aspects into account at an early stage of product development. However, there is a lack of a consistent approach for using the available environments for user-optimized product development of power tools. With current simulation environments, it is not possible to predict postures and musculoskeletal stresses of a completely redesigned power tool during use. Therefore, new co-simulation environments need to be provided that link data from different environments and enable new possibilities for evaluation. This paper presents the basic research approach for predicting body postures and musculoskeletal stress due to disruptive design changes.

3 Research Approach

The research approach (see Fig. 1) aims to develop a holistic method for the simulative evaluation of human stress during the use of power tools for different applications. This approach enables to make disruptive design changes to power tools and to evaluate human stress at an early stage of product development without having to conduct costly studies with test subjects.

To achieve this goal, the most likely posture adopted by the user during an application must first be predicted and, in the next step, the user's stress must be evaluated based on a simulation. As can be seen from the current state of research, model approaches already exist for these two sub-steps, but they cannot be used for power tool applications without adaptions. Furthermore, for a combination of the model approaches, the interfaces have to be defined and coordinated. Therefore, to achieve the overall goal, a co-simulation of existing simulation environments is aimed at.

First, a preliminary study will be conducted to develop the posture prediction method (Method Development). In addition to building the study design, this includes the development of a generic power tool dummy and a study with subjects. Secondly, the developed method is applied to a large number of subjects and the prediction model is built (Model Development). Then, the model will be validated by matching posture predictions with the movements of subjects from the main study (Method Plausibilization). Hereby, the validation uses data sets that were not used to develop the predictive model. Finally, a method generalization is provided that allows the applicability to other systems (Method Generalization).

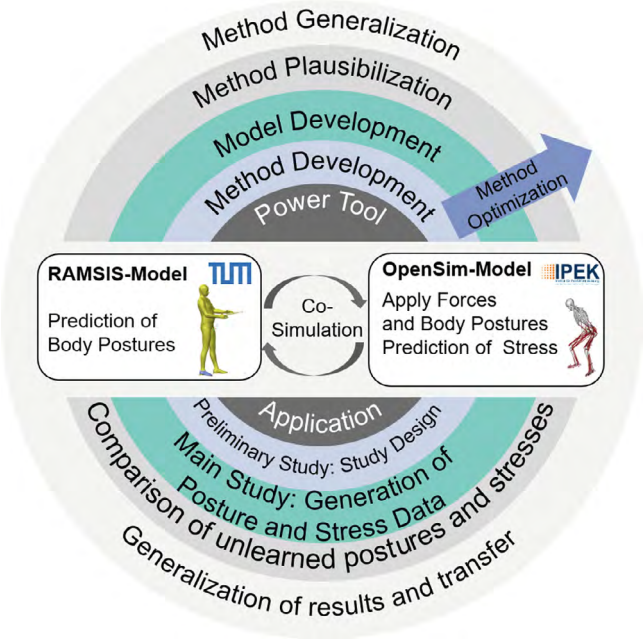


Fig. 1. Research approach for developing a method for simulative evaluation of human stress during the use of power tools for different applications.

4 Discussion and Conclusion

The user-centered design of technical systems such as power tools is becoming increasingly important and requires the consistent ergonomic design of new products. Today, existing systems are primarily designed from a functional point of view, which severely limits the scope for ergonomic adaptations. Disruptive design changes lead to a significantly increased development risk and costs with existing approaches, which means that usually only minor design changes are made. To design products ergonomically in the future, approaches are needed that allow valid statements on ergonomic design at a very early stage of product development.

This paper presents a methodical research approach with the help of which application-specific prediction models of user stress can be developed for product development. This is achieved by adapting existing simulation environments for the prediction of posture and human stress for the power tool application and combining them through co-simulation. To explore the described approach in detail, there are several challenges to be met. Since RAMSIS can only predict postures, the movement would need to be simulated by stringing together individual postures. This additional step of chaining should be bypassed in the initial method development and therefore a static power tool application should be chosen first. Further challenges in the method development are the setup of the co-simulation so that a standardized data exchange between the two simulation environments can take place, as well as the definition of a suitable test design. Here,

the conflict of interest between a prediction model that is as accurate as possible and valid for many applications and a manageable scope of experiments must be resolved.

Through the developed research approach, the technical design of power tools can be reconsidered entirely in a user-centered way, which will lead to more ergonomic power tools with higher usability. New handle geometries and positions can change the handling of power tools and thus, in addition to the stress caused by vibrations and dust, musculoskeletal stress can be taken into account during development.

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Hofstede's Cultural Dimensions Theory: Can Researchers Add More Cultural Dimensions?

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Abstract. This research endeavors to justify why tribalism__a sense of belonging to an individual's tribe, superiority among other tribes, blindly loyal to a tribe, and demeaning outgroups__is a different cultural value different from Hofstede's initial first four dimensions of 1984 in 76 countries. The author used the bivariate analysis and data from Corruption Perception Index, Tribalism Index, and Hofstede's Cultural Dimensions' Study 2001. The results show that tribalism is different from Hofstede's initial cultural values of uncertainty avoidance, PD, masculinity, and collectivism. The results confirm the author's argument why tribalism should be added to Hofstede's Cultural Dimensions Theory. This study validates the concept of tribalism as a testable dimension by testing the relationship between tribalism and corruption using linear regression analysis. Researchers can use tribalism as a new cultural value that differentiates societies from one another.

Keywords: Tribalism · Power distance · Masculinity · Uncertainty avoidance · Collectivism · Hofstede's cultural values

1 Introduction

Geert Hofstede originally developed his cross-cultural communications theory, known as Hofstede's Cultural Dimensions Theory (HCDT), a framework used to recognize and explain the variations in culture across countries and discern (perceive) the approaches that organizations do business across diverse cultures. The optimum goal of Hofstede's study in 67 countries was to determine the dimensions in which cultures vary. The first version of HCDT comprised only the first four dimensions, including individualism/collectivism (COL), power distance (PD), uncertainty avoidance (UA), and masculinity (MAS)/femininity [1]. Later on, Hofstede added two more cultural dimensions of indulgence/constraint and short-term/long-term orientation. This new added dimension implies that Hofstede's cultural theory missed some decisive cultural values in some societies that distinguish these societies from other societies worldwide. In the world we live today, no one can deny that tribes exist almost everywhere around the globe, and tribalism as a by-product of an unintended but inevitable secondary result of some tribes' behavior is also evident.

Jacobson and Deckard [2] unveiled that South Asia, Southwest Asia, and many African countries still have extended families, tribes, and specific races. Furthermore,

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 468–482, 2022.
https://doi.org/10.1007/978-3-030-85540-6_60

tribes are the primary cultural system in the African, Arab, and Asian collectivistic [3] cultures. Nevertheless, researchers have not agreed on one single definition for tribalism. Based on the Engaged Theory, tribalism is how tribe members live their lives based on kinship-based organization, verbal communication, analogical query, joint production, and mutual exchange [5]. A tribe is described by De Glazer and Moynihan [4] as a name for a cultural association that seems recognizable by origin and a shared history [4], despite how scholars have described tribalism, the shared idea amongst these diverse meanings yet exists. For instance, loyalty, face-saving, belonging, identity, commitment, oneness are attributes linked to tribe and tribalism. In this study, in particular, the author defines *tribalism* as a sense of belonging to an individual's tribe, the feeling of superiority among other tribes or groups, and blind loyalty to cultural groups with different lifestyles, mindsets, behaviors, and the obligation of being owed to tribe despite the honesty and authenticity of being belonging to a tribe.

Tribalism is a notion that appears to pertain to special Asian, Arab, and African societies. However, the author claims that it is related to all nations based on the tribalism index (TRI) revealed by Jacobson and Deckard in 2012. In this respect, the way that tribalism is being by many researchers currently shows that tribalism relates to mere actions that describe cultural unity and society. For instance, clan members perceive a feeling of affinity and obligation due to kinship. Based on the TRI, most cultures have some level of tribalism. Hence, it is shocking to understand that global management and cross-cultural scholars have often overlooked the uniqueness of tribalism. Tribalism is a different concept that necessitates being validated and considered a cultural value that differentiates between societies and nations.

In this study, the author endeavors to add knowledge to the literature by showing that tribalism pertains to every society, and it is different from Hofstede's initial social values of masculinity (MAS), uncertainty avoidance (UA), and collectivism (COL), and power distance (PD). Specifically, the author claims that researchers need to acknowledge tribalism as essentially an added measure of the lifestyle, distinct from cultural values suggested by contemporary widespread cultural frameworks, including Hofstede's cultural values [5]. The preceding analysis guides the initial investigation inquiry, "Is tribalism a different cultural value that is distinct from Hofstede's COL, UA, MAS, and PD?".

Theoretically, this study results add to the knowledge by investigating tribalism and explaining that tribalism is different from Hofstede's COL, PD, UA, and MAS cultural values. Besides, the author confirms the concept of tribalism by checking the link between tribalism and corruption and validates the concept.

For practitioners, the study results provide helpful direction to international organizations in knowing the significant power of tribes in today's global business. In Yemen, Oman, Bahrain, the United Arab Emirates (UAE), Qatar, and Kuwait, tribalism is a social supporter [6], and group nature links strictly to the Middle Eastern and Arab society [7], where many international corporations run their business. Therefore, understanding tribalism could enable global companies to know the increasing intensity of a society and its impact on management practices.

2 Reviewing Literature and Developing Hypotheses

The author shows that the concept of tribalism potentially carries collective, political, private, and self-seeking by reviewing the literature. These notions are imbued in the passion of individuals or groups to dominate, utilize, or attack others [8].

As long as tribalism is a primary form of action, few researchers claim that tribalism is a component of the nationwide culture [9]. Tribalism is intimately linked to a nation's culture, including cultural and social elements such as religion, values, language [10]. Nevertheless, tribalism differs from Hofstede's national culture since Hofstede's state culture is constructed on different elements, including religion, education, laws, language, law, and politics [11]. However, tribalism relates fundamentally to a clan subculture of social groups with unusual behaviors, beliefs, and lifestyles [12].

The literature analysis reveals that tribalism is perceived as a different notion from Hofstede's national culture but pertains to every society. To get this prospect, acknowledge that Jacobson and Deckard's [2] included five critical dimensions in the TRI. To comprehend the size of tribalism in every society, researchers must recognize the constituents describing a tribal culture. In this sense, the TRI developed by Jacobson and Deckard [2] claimed that five determinants explain tribal societies:

1) group grievance__the what extent special population societies believe aggrieved and are dropped outside of state rules);
2) gender inequality__the uneven dividing of positions in the community;
3) ethnic fractionalization__to what degree nation is heterogeneous. Heterogeneity increases with widespread tribalism;
4) perception of corruption__to what extent members of a society committed corruption activities;
5) population demographics__to which extent people in a community are the extent are indigenous; remarkably, tribal nations prefer to have greater indigenous or aboriginal populations. Increased tribal cultures favor having higher factors of each of the five determinants. As discussed above, tribalism pertains to the most prominent nations and possibly affects transaction ends in specific communities. Hence, the scholar proposed that tribalism is a different cultural value separate from contemporary social dimensions. Social culture defines how a society deals with a conventional set of opinions, beliefs, and values [5]. Moreover, the study has confirmed that certain traditional values or practices illustrate a relationship with various single-level behaviors.

Hofstede's cultural framework (HCF) is currently is the most commonly used research framework. This research study's center contrasts with Hofstede's cultural values of COL, MAS, UA, and PD. The Hofstede dimensions give the foundation for several substitute frameworks. Indeed, the GLOBE study framework is a distinguished cultural framework that can be tracked to Hofstede's activity [13]. Besides, even though Hofstede founded his four initial cultural dimensions back in the 1970s, his four initial cultural dimensions have endured strong in the contemporary setting [5].

The author in this study declares tribalism as a different cultural value from Hofstede's PD, MAS, COL, and UA since tribalism appears not fundamentally address

subjects related to UA, COL, MAS, and PD. As defined by Hofstede, COL is the degree to which society members want to belong to communities with a solid and undoubted spirit of commitment. PD is to what extent the community members allow and support power differentials. UA is to what extent members of the community favor reality over ambiguity. Furthermore, MAS is the extent to which a nation admires manly values, for example, competition and acquiring assets over female values such as relationship building and quality of living [14]. There is no suspicion that there is some similarity between tribalism and those dimensions; nevertheless, the author demonstrates that tribalism covers crucial features of a culture not touched by HCF.

Nonetheless, some researchers might claim that tribalism is slightly related to COL. The author supports the case that tribalism petitions concepts greatly deeper than commitment and dedication to a social society or an insignificant favorite for relating to societies. Loyalty to a tribe, in the context of tribalism, is usually coupled with intense harmful compassion for somebody the group outsiders [15]. One case of extreme negative attitudes is the hunger of an individual or a society to assault, dominate, or misuse others [8]. In the setting, as mentioned earlier, tribalism addresses the tribal society members' relationships within a feeling of family that is exhibited in the tribal and extended family members' eagerness to support and defend the tribe.

Different from COL, tribalism is linked to blood fights [16] and honor slaying [17, 18], which are founded in tribal regions. In Middle Eat (ME) societies, tribes' fame is normally related to families and individual's reputations and dignity. Neither Hofstede nor the GLOBE study has associated COL with honor crimes, individuals' needs, or blood feud to abuse, dominate and assault others [8, 19]. Hofstede's and the GLOBE study have imagined COL as the doctrine that an individual's lifetime and undoubted loyalty relate to the community that a person is undividedly a part of a group. In COL, the community or the group does not necessarily do not from the same tribe, a connection group, or a larger family. Every society of homogenous individuals with shared names or concerns could exist collectively. For instance, people from diverse ethnic groups and tribes have lived collectively for several years in big cities. To sum up, loyalty is hardly the common denominator linking COL and tribalism.

Lastly, in testing tribalism from selling, buying, or a marketing viewpoint, features such as a feeling of kinship bonds and community are of interest [20]. Moreover, the enthusiasm of the individuals in a tribe to support and guard the tribe is notable [8]. These features further imply that COL is tribalism is different from tribalism. Therefore, tribalism and COL are separate constructs. Consequently, the author argues that tribalism is a cultural value that is distinct from COL and proposes hypothesis1 (H1):

H1: Tribalism is a social value that is separate from COL.

In addition, the author assumes tribalism is different from MAS__the extent a society admires manly values, including competitiveness and the achievement of competence above female, including connection building and state of living [14]. Tribalism approaches more widespread problems than minor gender identity and gender inequality, competitiveness, quality of life, wealth acquisition, and connection building. Given tribalism, the author argues that tribalism discourses of how members of a tribe treat, portray, and socially judge gentlewomen in society.

Based on a study conducted by Boungpui [19], Northeast Indian tribal culture lessens women's social standing and the importance of their achievement in their houses. In various Indian tribal populations, gentlewomen are emotionally depressed by special mottoes such as "a lady and an ancient wall can be substituted at any moment"; "the intelligence of a gentlewoman does not reach to the shores of a river" [21]. The gentlewomen's disgrace signifies how tribe members in India appreciate ladies and how females are portrayed and treated in the community. Contrasting Indian tribal cultures, in the United States masculine nation, women's work and social status are extremely acknowledged and valued. In conclusion, the author argues that tribalism is a social value that is distinct from MAS and proposes hypothesis 2 (H2):

H2: Tribalism is a social value that is different from MAS.

PD, as defined by Hofstede, is to what extent societal members admit power differentials. PD addresses subjects related to the degree of power anticipation and authority approval by the reduced influential organizations, including workplace and institutions, including the tribe, community, family, and school. Little powerful people usually assume unequal power allocation and accept that power differential with no additional approval or reasoning.

In societies with great PD, power bureaucracy is visible, and people admire their superiors without challenging their authority [22]. In societies with little power PD, people value independence and individual responsibility [22], implying that authority is well scattered, participated, and admitted. It also indicates that community members understand themselves as just.

In tribal communities, PD appears not significantly address concerns related to power hierarchy and differential. Hierarchy and bureaucracy are not tribal compositions [23]. Nevertheless, in tribal communities, power PD describes obedience by age, elders' respect, making decisions by consensus, and choosing heads based on their service to the tribe [23]. Tribe members admire seniors for their experience and knowledge [5]. For instance, Indigenous Indian youngsters are instructed by their mothers and fathers to display their honor in the appearance of seniors by being calm; and youngsters are supposed to be peaceful in the presence of seniors to display their admiration [24].

Different from societies with large PD where people admire their seniors without challenging their authority [22] in tribal cultures, administrators get their influence rank by how significant aid and support they award to the tribe [25]. Tribe members challenge leaders of their help they granted to the kindred culture ere and throughout their lead times. Furthermore, an agreement is how tribes secure their resolutions [26] to determine their managers, which indicates that members in tribes do not assume their heads to possess power above them with no questioning, discussion, and consensus. Members in the tribe only allow order in rank order, which suggests that everyone has a position to justify respect of elders and age [27]. Following the argument mentioned earlier, the author proposes hypothesis 3 (H3):

H3: Tribalism is a social value that is different from PD.

As defined by Hofstede, UA is to what degree members of the community favor certainty over vagueness. UA discusses subjects related to the financial well-being and emotional situation of different individuals in their community. In countries with high UA, people

might have several jurisdictions and regulations guiding each obscure, event, or unexpected case. Society also has an increased understanding of new beliefs, thoughts, ideas, and ambiguity [28].

Nevertheless, UA does not fundamentally address how the community concerns with an unexpected or ambiguous circumstance, as [5] reported. In tribal cultures, UA addresses individuals' concerns and anxieties for different community members [29]. There is no assumption for these members' concerns because tribe rulers understand who wants emotional and financial assistance and how to pay attention. Therefore, the author argues that Tribalism is distinct from UA as defined by Hofstede [5] and proposes hypothesis 4 (H4):

H4: Tribalism is a social value that is different from UA.

To sum up the preceding series of discussions, the author argues that Tribalism is a social value separate Hofstede's cultural values of COL, MAS, UA, PD and posits hypothesis 5 (H5):

H5: Tribalism is a social value separate from Hofstede's cultural values of COL, MAS, UA, AND PD.

3 Tribalism and Corruption

In this research, to confirm the tribalism construct validity, it is essential to show that tribalism relates to predicting an outcome of concern to the global management society. In that regard, several cross-cultural management professors are excited about concerns of ethics and corruption. Therefore, the author examines and analyzes how tribalism links to exploitation and corrupt practices. Corruption is the ill-usage of allowed authority by an official, a public or private deputy, an administrator, executive for personal earnings [30]. Seldadyo and De Haan [31] named seventy reasons for corruption, such as cultural, economic, and non-economic factors. Comparatively to cultural variables, many scholars have reasoned that ethnolinguistic uniformity is likely to reduce corruption [32]. Hence, heterogeneous tribal societies are expected to be corrupt, considering tribes are profoundly fragmented societies (Jacobson and Deckard 2012).

Corruption is associated with tribalism by several scholars. In several situations, tribalism is fully understood by Gullette [32] as a kind of corruption created by kinship relations. Jacobson and Deckard [2] similarly understood tribalism as the principal cause of corruption crimes in several unethical countries due to kin systems that drive government servants to exercise nepotism and partiality to reinforce their extended tribe and family members. In his empirical study, Abdelrahim [33, 34] found that tribalism causes corruption in many countries because of several factors, including gender inequality, ethnic fractionalization, and group grievance.

AS researchers agreed on, people's values and norms significantly define corruption [35]. Indeed, every tribe has its norms and values that promote corruption. For instance, it is a pattern amongst administrators in African tribes to accept awards viewed as bribery in Western society [35]. Another social norm amid tribes in Africa that could produce corrupt practices is communalism__the commitment to one's ethnic class rather than the wider society [35]. Socialism might make African kindred communities exposed to

corruption since it creates the difference between special and state reserves to become suspicious. Subsequently, communalism sets individuals under substantial monetary pressure [36]. Individuals are accountable for supporting their immediate families and relations. That personal necessity forced by extended family and kinship system can make people become engaged in corrupt acts to satisfy their commitments [37] through favoritism and nepotism. Following the previous analysis, the author claims that tribalism is expected to rise corruption practices and posits hypothesis 6 (H6):

H6: Controlling PD, UA, COL, and Mas, tribalism will positively correlate with corruption.

4 Methods

4.1 Method of Data Collection

The author utilized datasets from three separate sources, Jacobson and Deckard TRI, the Corruption Perceptions Index (CPI), Hofstede's Study [5]. To test six hypotheses__ the relationships between the one dependent variable (corruption) and one independent variable (i.e., tribalism) and COL, PD, UA, and MAS as control variables__ the author employed secondary datasets from several resources. Besides, the researcher utilized the same secondary data to examine the correlation between tribalism and PD, MAS, COL, and UA.

4.2 The Dependent Variable

The country-level corruption, which was borrowed from CPI developed by Transparency International [38], is the dependent variable in this study country level. The CPI clusters data of various sources that present business individuals and country specialists with understandings of the government division's corruption practices. The CPI collected the multiple measurements of corrupt practices to produce an index-free at https://www.transparency.org/news/feature/corruption_perceptions_index_2017 research. Examinees (i.e., experts and company managers) answered questions that catch corrupt practices in the government section, including favoritism, partiality, and bribery. For instance, interviewees were requested to say their views on how public office workers exploit their positions and how service workers in the government sector are banned from using their professions for individual benefits. The CPI lists 180 regions and countries and is estimated by obtaining corruption attitudes in the last twenty-four months in twelve different organizations that gather data from thirteen various roots. The CPI applies zero (extremely corrupt) to one hundred (highly clean and lawful).

4.3 The Independent Variable

The country-level tribalism is this study which is the independent study variable. The author used a secondary dataset from Transparency International (TI). The TI composed the different tribalism determinants to construct a TRI. The TRI rates 160 nations and involves five determining factors associated with tribal communities and societies. The

primary determinant is racial and linguistic fractionalization__the degree to which a nation is mixed. The second factor is population demographics__the extent to which the indigenous people are indigenous; very tribal communities are inclined to have higher indigenous or native populations. The third constituent is gender justice__the extent to which women and men receive equal societal positions). The fourth determinant is group grievance (i.e., injustice)__the extent to which a special society believes displeased and dropped out of administrative and political methods. The fifth is corruption perceptions___the degree to which societal member involves in corruption activities). TRI scores vary from one for considerable tribalism level zero to no tribalism at all. Jacobson and Deckard [2] employed a weighted cluster of the five specified dimensions to develop the TRI. Here is the TRI formula:

TRI = Group Grievance + 2(Gender Equality) + 0.5 Ethnic Factionalism + Corruption Measure + 0.5 Indigenous Population.

4.4 The Control Variables

Culture makes the base for moral behavior and defines what is regarded as unethical and ethical [39]. In this research, the author controlled for the cultural values of PD, COL, MAS, and UA due to their impact on the outcome between the dependent and independent variables. Geert Hofstede's broadly studied and quoted research was the source of this study's control variables country-level dataset. Hofstede built the above-mentioned cultural values utilizing a comprehensive experimental examination of 100,000 plus surveys completed at IBM between 1967 and 1973.

4.5 Hypotheses Testing

To examine hypotheses H1, H2, H3, and H4, the author applied the bivariate correlation analysis in SPSS 26. The bivariate correlation examination enables the researcher to analyze tribalism and compare it with Hofstede's UA, COL, PD, and MAS. Therefore, to examine Hypothesis H1 through H4, in this research, the researcher utilized correlations from the bivariate analysis (Table 1 shows Correlations of Pearson Test; Table 2 shows the Correlations of Spearman's Test). Table 2 confirms no high correlation between

Table 1. Correlation coefficient - Pearson

	Tribalism	PD	COL	MAS	UA
TRI	1	0.523**	0.462**	0.048	0.032
PD		1	0.471**	0.017	0.102
COL			1	−0.232*	0.053
MAS				1	0.0.008
UA					1

**The level of correlation is (notable) significant at 0.01. *The level of correlation is significant at 0.05. TRI denotes tribalism.

tribalism and PD, COL, UA, and MAS cultural dimensions. Both tests (i.e., Spearman's & Pearson) estimate the robustness of the direct and non-linear correlation between PD, COL, UA, AND, and tribalism.

Table 2. Correlation coefficient - Spearman

	Tribalism	PD	COL	MAS	UA
TRI	1	0.566*	0.454**	−0.042	−0.029
PD		1	0.416**	−0.034	0.042
COL			1	−0.288*	0.032
MAS				1	−0.065
UA					1

**The level of correlation is significant at 0.01. *The level of correlation is significant at 0.05. TRI denotes tribalism.

Researchers adopted the Pearson correlation examination to examine the strength of direct relations between variables that are normally distributed. In contrast, Spearman's correlation analysis is applied to examine the power of direct and also non-linear correlations between variables that are normally distributed and not normally distributed [40]. Considering Shapiro-Wilk's normality test (Table 3) revealed that three of the five variables are normally distributed, and two are non-normally distributed data. Hence, the author chose Spearman's correlation examination to examine hypotheses H1, H2, H3, and H4.

Table 3. Test of normality based on Shapiro-Wilki

	Stat.	df	Sig.
PD	0.963	76	0.024 < 0.05 Significant- Not normally distributed
MAS	0.977	76	0.174 > 0.05 Not Significant-Normally distributed
UA	0.962	76	0.021 < 0.05 Significant-Not normally distributed
COL	0.896	76	0.000 < 0.001 Significant – Not normally distributed
Tribalism	0.985	76	0.496 > 0.05 Not Significant- Normally distributed

Note: df = Degree of Freedom; SIG. = Significance; Stat. = Statistics.

According to Spearman's correlation examination (Table 2), Mindrila and Balentyne [40] (see Table 4), tribalism and MAS are not correlated ($r = 0.048, < 0.3$), which shows that TRI is distinct from Hofstede's MAS VALUE, and accordingly, H2 is confirmed. Table 2 also reveals UA and tribalism are not correlated ($r = 0.032, r < 0.3$), that TRI is distinct from Hofstede's UA, and accordingly, H3 is confirmed. At 0.05, COL and TRI have a weak and notable correlation at 0.05 ($r = 0.462, r > 0.5$). Therefore, H1 is supported. Lastly, there is an infirm and significant association between PD and tribalism

($r = 0.523$, $r > 0.7$). Therefore, H3 is supported. H4 and H3 are approved because a fragile correlation means a weaker probability of a negligible or a weak connection between COL and tribalism and PD and tribalism.

Table 4. The strength of the relationship between variables/The rule of thumb.

(r) /Absolute value	Relationship/Strength
$r < 0.3$	Weak or no correlation
$0.3 < r < 0.5$	Brittle
$0.5 < r < 0.7$	Modest
$r > 0.7$	Powerful

Source: Mindrila and Balentyne [41]

Finally, the author applied linear regression analysis to examine hypothesis five H5. The author used linear regression examination since the data for all variables (i.e., control, dependent, and independent variables) are at the nation level (Table 5).

Table 5. Descriptive statistics (N = 76)

	SD	Mean
COL	23.46	66.18
PD	19.58	66.00
MAS	49.25	17.94
UA	64.92	22.21
COR	17.99	46.38
TRI	0.207	0.492

TRI denotes tribalism, ***P < 0.0001, *P < 0., **P < 0.001;

5 Results

Using linear regression technique, the results confirmed hypothesis H3 ($\beta = 0.433$, p-value = 0.000, < 0.000, significant). In addition, H4 ($\beta = -0.004$, p-value = 0.026, < 0.05, significant) (see Table 6).

Table 6. Outcomes from the Linear regression examination.

Parameter	Coefficients	Significance
Constant	93.73	Change is significant since p-value is < 0.000
R	0.815	Change is significant since p-value is < 0.000
R^2	0.664	Change is significant since p-value is < 0.000
F change	40.96	Change is significant since p-value is < 0.000
Tri	$\beta = 0.47$	Change is significant since p-value is < 0.01

6 TRI Denotes Tribalism

6.1 Discussion

The Study Findings

As the study findings show, the data for TRI, PD, COL, UA, and MAS confirmed three H1, -H4, H3, and H5. The test results showed tribalism and MAS are not correlated, which means that TRI is distinct from Hofstede's MAS, and accordingly, hypothesis H2 is approved. As stated shortly, tribalism covers fundamental characters of culture that are not touched by Hofstede's cultural theory. The author concludes that tribalism is different from MAS__the extent to which a nation admires masculine values, including competitiveness and possession of money, over female values, including connection building and state of life [5]. The results validated that tribalism addresses more widespread concerns than competitiveness, mere gender equality, relationship building, wealth acquisition, and quality of life. In reality, tribalism addresses how members in tribal communities' treat, depict, and culturally admire gentle women in the nation.

The study findings also supported H4 and revealed no correlation between UA and tribalism, suggesting that TRI differs from Hofstede's UA. Hofstede explained UA to what extent society members favor reality over doubtfulness. Nevertheless, in TRI, UA does not significantly address how the community handles unexpected or ambiguous circumstances, as Hofstede defined. In tribal communities, UA addresses individuals' anxieties for other individuals of their community [29]. There is no expectation involved since tribe heads understand who wants monetary help and passionate assistant and how to trade with it. Therefore, it is reasonable that UA does not associate with TRI, and hence, the two concepts are different.

At 0.05 level, there is a limited and notable correlation between COL and TRI. Therefore, H1 is supported. H1 is confirmed since the incredibly low correlation means a greater probability of a fragile or negligible link between TRI and COL. The author believes there is some limited correlation between COL and TRI; nevertheless, the author argues that tribalism measures society's necessary aspects not inscribed by COL.

Some could claim that tribalism is slightly related to COL. Members of a clan or a tribe certainly have a sense of loyalty and relating to their extended families and tribes. Nevertheless, TRI addresses ideas much more widespread than the commitment to cultural groups or a little choice for relating to societies. In tribalism, commitment to a clan is usually coupled with powerful and gloomy feelings group outsiders [15]. In

that setting, TRI addresses tribal members' connections within a feeling of connection, shown in members' eagerness to support and defend the tribe.

Unlike COL, TRI is linked with honor killing [17] and blood feuds [16], which started in tribal territories. In Arab societies, tribes' names are conventionally related to families' honor and individuals' dignity. Both Hofstede and the GLOBE study have associated COL with honoring killings, individuals' needs to exploit, dominate and assault others, or honor killing [8]. Hofstede [5], the GLOBE study [12] has mentally visualized COL as the belief that a person's life and undisputed loyalty relate to the community of which she or he is simply members. In COL, the community or the group is not necessarily from an extended household, one race, or a clan group. Every society of homogenous individuals with shared interests or identities could exist collectively. To sum up, loyalty is solely the basic denominator linking and COL. Therefore, loyalty is expected to be the rationale why the extremely low correlation between COL and TRI exists.

Lastly, the results show that there is a slight and notable association between TRI and PD. Nevertheless, tribalism is different from PD__to what extent society members allow power disparity__as the notion of TRI does not fundamentally address concerns related to power divergence marked by PD. In tribal communities, PD does not significantly address dilemmas related to power hierarchy and differentials. Hierarchy does not belong to a tribal structure [23]. Nevertheless, in cultures with tribes, PD addresses obedience by age, respect for elders, leaders' selection based on their help to the tribal society, and making judgments by agreement [27]. Tribe members admire seniors for their experience and knowledge [25].

Unlike large PD societies, where people admire their chief without challenging their authority [22], in tribal nations, heads get their authority state by how substantial assistance and support they award to the society [25]. Tribe members challenge leaders to assist the tribal society ahead and throughout their lead and administration times. Furthermore, an agreement is how tribes make and execute their rulings [26] to elect their chief heads and reach decisions, which indicates that tribe affiliates do not assume their tribal bosses to have authority over them with no consensus and consultation. Tribe members hardly admit a hierarchical order which means everyone can justify respect of elders and age [25]. Hence, some think TRI has a weak association with PD because hierarchical systems exist in PD and TRI.

By applying the linear regression analysis, the study findings confirmed hypothesis 3 (H3). In H3, the author theorized that TRI is undoubtedly related to corrupt practices after controlling for UA, COL, PD, and MAS. The study findings validated H3 and validated the positive association between corruption and tribalism after controlling for UA, COL, MAS, and PD. Those outcomes confirm the conclusions by Precious [43] and Ghosh [20] as tribalism links to corruption.

7 Conclusions

Theoretical Implications

While prior studies have centered largely on Hofstede's cultural values, this research garners additional awareness of society by combining tribalism. By analyzing how tribalism in culture is linked to corruption, the research validates the concept of tribalism.

It explains tribalism's connection to corruption, given the supported interest in knowing the corruption factors in the tribal nation. This study gives additional insights exceeding our existing knowledge.

While a lot of research has centered on the relationship linking tribal characters and corruption within African, Asian, and Arab settings, spreading the investigation to different tribal societies will produce more generalizable perspectives. By examining the four hypotheses, the study proved the usefulness of the TRI concept in Arab and African communities. The current work improves researchers' knowledge of TRI within the extension of this cultural value. By advancing the understanding of tribalism in culture, the author offers advanced knowledge of an added cultural dimension. Finally, by examining how TRI is related to corrupt practices, it is feasible to validate the construct TRI and confirm its relevance to corruption.

Practical Implications

These study's findings could equip practitioners in international firms with awareness of the explanatory strength of TRI in today's international business. Understanding the TRI forces could allow multinational corporations more power to recognize the increasing power of tribal society. Besides, knowing the dynamics of tribalism might be a decisive constituent in defining strategic supervision ends such as new global market entry choices. Finally, the study findings could also encourage international business practitioners to integrate behavioral understanding into their business activities overseas. Hence, international businesses should consider training their staff in tribes and tribal behavior to avoid the consequences of tribalism and its pitfalls.

Limitations and Future Research

These study results are specified to 76 countries or nations in particular countries. Some other decisive tribal regions and communities need to be included to strengthen the study findings and generalizability. Therefore, the author suggests that future research extends on the existing conclusions in other regions and countries worldwide.

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The World's First 'Pop-Up' Urban Airport: A User-Centred Design Approach to Understand the Customer Journey

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Abstract. Urban Airport is a transportation infrastructure for electrically powered Vertical Take-Off and Landing (eVTOLs) aircrafts, or so-called flying cars. It is one of the emerging solutions for improving urban environments in terms of sustainability and traffic. This paper explores how adapting a human-centred design approach enhances passengers' journey through the future Urban Airport. In order to deliver a user-friendly experience, accessibility, comfort and efficiency are vital. Understanding users' journey throughout the Urban Airport will help us comprehend how the infrastructure should be designed for targeted user groups with different characteristics and expectations. This paper presents three user personas and associated storyboards to provide insights into the spectrum of goals, needs and frustrations of the Urban Airport potential users.

Keywords: Urban air mobility infrastructure · User experience · Flying cars

1 Introduction

1.1 What is an Urban Airport?

One of the most exciting developments in emerging future transport is the concept of Urban Air Mobility (UAM). UAM is an industry term for on-demand, passenger, or cargo-carrying air transportation services as a solution for improving urban environments. Recent advances in aviation technology have given rise to electrically powered Vertical Take-Off and Landing (eVTOLs) aircraft, also known as flying cars. These air transportation services are a solution towards growing demand for more sustainable and efficient forms of mobility in the future. With growing congestion in urban cities, UAM could help augment conventional mass transit services [1]. Within the Air-One project we are developing and testing the "world's first pop-up airport", an ultra-compact structure known as "Urban Airport" or "Vertiport", which is a key component in supporting electric aircrafts that take off and land vertically. Urban Airport is a space-efficient, portable, multi-functional and rapidly deployable structure that can be transported in conventional haulage containers to any location. The Air-One programme exploits a

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 483–490, 2022.
https://doi.org/10.1007/978-3-030-85540-6_61

major gap-in-the-market – lack of appropriate UAM infrastructure. Furthermore, Urban Airport supports the concept of a zero-emissions hub for future modes of travel while being a small foot-print infrastructure with minimal impact on the environment. One central question pertaining to the development of Urban Airport is how should it be designed to improve travellers' experience (Fig. 1)?



Fig. 1. 3D visual of urban airport in coventry, UK.

1.2 Why a User-Centred Approach is Necessary to Improve the Usability and Efficiency of Urban Airports?

Optimising the usability and accessibility of Urban Airport is of paramount importance to ensure it is efficient, accessible and user-friendly, as it is expected to serve a large population with different characteristics. Indeed, UAM infrastructures are designed to meet future demand for inner-city/regional business travel, with business travellers accounting for 12% of airlines' passengers, and 23% of business passengers travel domestically on direct air routes solely within the UK [2]. The biggest age groups of business passengers are 35 to 44 and 45 to 54. The most common activities for business passengers is to attend a meeting or provide a service [2]. For non-business passengers, the most common airport activities include check-in, security and passport control, as well as carrying luggage [3]. Therefore, understanding users' journey throughout the UAM will help us to understand how the infrastructure should be designed for targeted user groups with different characteristics and expectations.

1.3 How Can a User-Centred Approach Inform the Design of Urban Airport?

The present study explores how adopting a user-centred design approach enhances individuals' journey through this future UAM infrastructure. Contemporary airports can be operated at the minimum level of passenger experience (i.e., what passengers require), complying with different regulations, but not delivering top-quality in terms of what passengers expect and value [4]. Another aspect of passenger experience in Urban Airport is the level of stress generated during a journey [4]. These levels can be used as a

framework to identify passengers changing needs and expectations via the red, amber and green "pain points" and "exciters" of personal air travel [5]. These pleasure and pain points can be illustrated by personas and storyboards to envision possible situations that cause different levels of stress in a generic airport environment. This paper will present three user personas and associated storyboards to learn about the spectrum of goals, needs and frustrations of the UAM potential users.

1.4 What are Personas and Storyboards?

The personas method is widely used throughout the design process to describe archetype of users. It is mostly utilised at the beginning of a project for ideation to position the user at the centre of the design [6]. Other benefits encompass focusing on the most important user group, their goals and the potential issues they will face [7]. Personas also present typical users' characteristics, identifies their potential behaviour and preferences [8]. Moreover, persona descriptions include a name, personality features, socio-demographics and often a photo accompanies the description [9], this helps to personalise them and give them a 'voice' in the design process. Although, personas were originally developed as a tool for design inspiration [10], today they are a representation of a targeted demographic in the broad range of potential users. It has also been summed-up in the following terms: *a persona is a representative of a user group, it is not the average of a user group* [6].

Personas can also be used in storyboards. Usually, storyboards represent expected situations in a determined environment in which individuals interact with a service, an object an environment or a combination thereof. A storyboard communicates a story through images displayed in a sequence of panels that chronically creates a whole story. This tool visually predicts and explores user's experience with a product or service [11]. Storyboards place people at the heart of the design process and are combined with one or more user personas. Within this paper we also expand the traditional storyboard to indicate the red, amber or green pain point or exciters for each scenario depicted and based on the reviewed literature. This methodology attempts to ensure that we do not 'design out' those positive experience that air traveller's value.

1.5 Aim of the Study and Research Question

Eliciting the pros and cons of a journey form the user's perspective, via personas and storyboards, has the potential to put usability and acceptance at the initial stages of the design process. This human-centred design aims to help designers in making the journey easier, more comfortable and more accessible.

To achieve this aim, the two following research questions will be addressed: *can we provide insights into who will be using UAM* and *what are the most important user's need in an UAM?* We will try to answer these questions by designing storyboards and personas. The results will then be discussed to inform the design of Urban Airport.

2 Method

The proposed personas of anticipated users with associated storyboards are based on a guidance from the project partners' business model and a review of the relevant literature. The personas creation process was structured around the identification of the Urban Airport end users, along with their goals, frustrations and needs. The storyboards consist of a series of sketches illustrating the most relevant moments of a user interacting within a specified environment. In the present study, the storyboards describe the personas "pain points" and "exciters" during their journey through the Urban Airport. Combining personas and storyboards has been shown to be beneficial in the user-centred design process for future transport systems [12].

3 Results

Two personas (Fig. 2 and 3) with their corresponding storyboards (Fig. 4 and 5) are illustrated in this paper. These two personas have a photo, demographics, profile, as well as goals, frustrations, and needs. A third persona is presented without illustrations due to space limitation. The reason for these personas to travel in an Urban Airport is for work or business purposes. This paper presents the following personas: Emma who is a Passenger with Reduced Mobility (PRM); Jin is a frequent business passenger in his 50s; Vicky represents the younger generation (Gen Y) of modern business travellers.

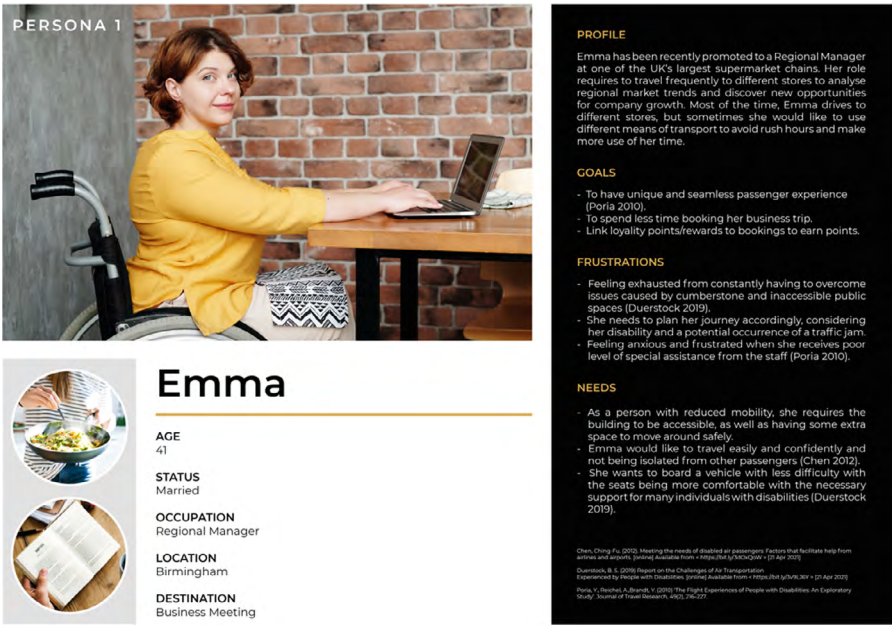


Fig. 2. Proposed persona of Passenger with Reduced Mobility (PRM).

Emma (Fig. 2) represents a broad group of business travellers aged 35 to 44. Considering Emma's disability, she needs to plan her journey accordingly, therefore she expects her experience to be unique and seamless [13]. As a person with reduced mobility, Emma requires the Urban Airport to be fully accessible, so she can feel included and confident with the flying experience.

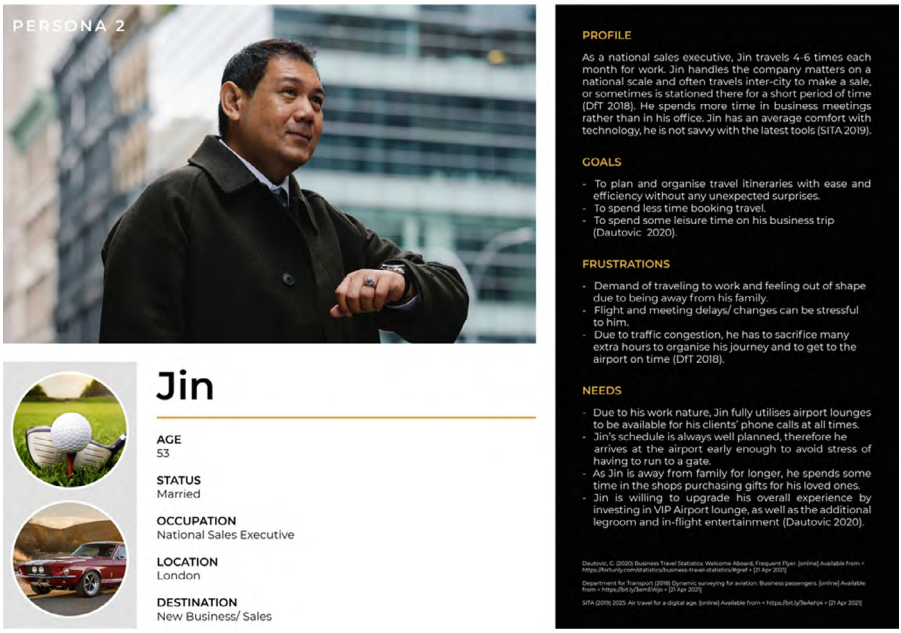


Fig. 3. Proposed persona of frequent business traveller.

With respect to the persona Jin (Fig. 3), he is more concerned about planning and organising his trip with ease and efficiency without any surprises. Jin's persona covers the largest group of business travellers aged 45 to 54. He is a frequent business passenger who travels 4–6 times each month for work. He arrives at the airport early enough, not only to avoid any stressful situations, but also to work whilst using airport facilities.

The third persona, Vicky is a less frequent traveller representing the 25–34 age group. She often check-ins at the last minute, as she does not like spending much time at airports [14].Vicky's focus is to create a better work-life balance by combing business travel with leisure purposes, as well as to bring some of her family members on a trip [15].

The accompanying storyboards illustrate the "pain points" and "exciters" of Emma's (Fig. 4) and Jin's (Fig. 5) air travel. Green colour refers to the lowest level of stress, amber to moderate and red indicates the highest level of stress associated with a journey through Urban Airport. Each storyboard consists of six images identifying the most important touchpoints and their associate level of stress within Urban Airport.

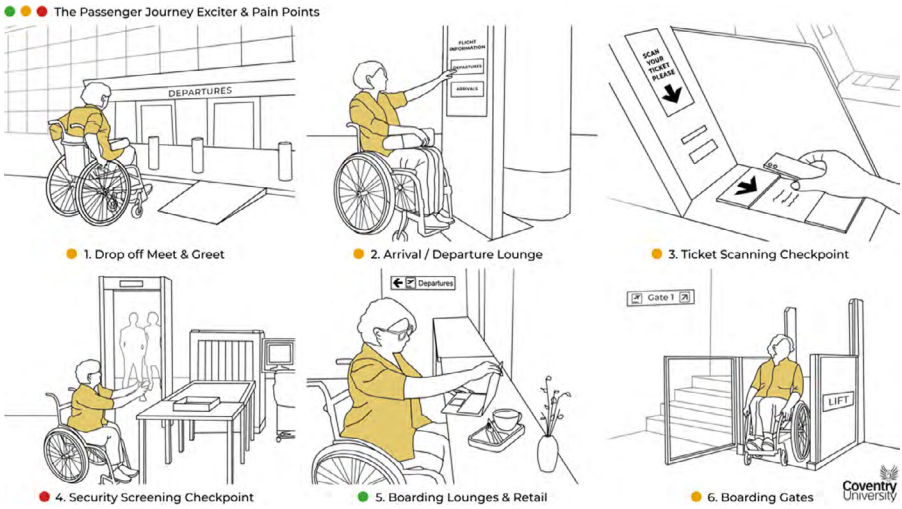


Fig. 4. Proposed storyboard of Emma's journey.

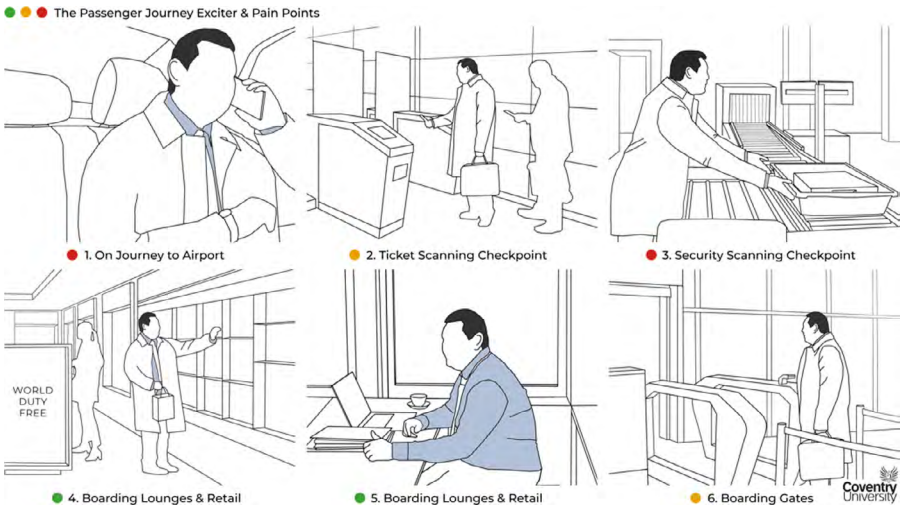


Fig. 5. Proposed storyboard of Jin's journey.

4 Discussion

The present personas and storyboard study contributes to bridge the gap in the fairly unexplored field of user experience in Urban Air Mobility. It proves insights into who will likely be using UAM, with a focus on Urban Airport. It also addresses what are the most important user's need in an UAM, with a focus on the touchpoints and their associated levels of stress.

The personas present three different types of users: the PRM, the frequent traveller and the less frequent business passenger. The latter wants their trip to become an experience, not only a mean to travel. Although these personas share a common goal, using the Urban Airport for a business trip in an urban area, their expectations, characteristics and goals diverge. Indeed, passengers with disabilities face numerous barriers when entering an airport. The building's cumbersome layout, design and navigation through different areas present challenges to passengers with mobility disabilities [16]. Frequent users seek reliability and efficiency of the service, and occasional travellers are looking for a premium service that stands out from the most common transport services.

The storyboard is useful to elicit where and when the pain and exciter points will occur throughout the journey in the Urban Airport. We can identify a linear increase in the frustration from the entrance into the infrastructure until the security screening control, the peak of the journey in terms of stress level. User experience could be enhanced significantly, by making this first part of the journey accessible (e.g. Emma), the entire control process fast (e.g. Vicky) and the waiting time comfortable for working while on-the-go (e.g. Jin). Another opportunity could be to present the traveller with a tangible "exciter" on immediate arrival at the Urban Airport, this can help alleviate the moderate to high stress levels associated with the wayfinding and check-in at airports.

A higher level of interpretation may allow comprehending which specific design features of the infrastructure improve user experience, despite personas' different needs and expectations. For instance, accessibility facilitates getting in, out and through Urban Airport. More specifically, it helps circulating around the UAM and going through the security control procedure. Ease of use relieves travellers from certain pain points, especially ticket scanning. Comfort improves user experience by mitigating the hassle of waiting in lounge areas. Altogether, accessibility, ease of use and comfort seem to be paramount to support inclusiveness, comfort and efficiency in Urban Airports.

The limit of this study is that personas and storyboards do not guarantee that people will behave similarly in the real world. They offer insights on how archetypes of users will interact with UAM infrastructures, which is a process closer to ideation than empirical observation. More research is needed to further our understanding of user-experience during UAM journeys. For instance, within this project the next step in user-centred research is to use a 3D model of the Urban Airport in virtual reality (VR) to allow users having an immersive experience with this infrastructure. In addition, the qualitative data collected from semi-structured interviews and focus groups would provide insights into public readiness and acceptance of urban air travel.

5 Conclusion

User-centred design helped identifying potential design issues related to the levels of stress that would otherwise be detrimental to the user experience. This is salient for new urban air transport infrastructures as the journey from the airport entrance to the boarding into the eVTOL may be stressful and unfamiliar. Accessibility, comfort and efficiency are three dimensions that should be implemented early in the design process to ensure a user-friendly and successful traveller experience for all.

Acknowledgements. The authors would like to thank the funder: Innovate UK under the Future Flight Challenge (FFC), a 4-year, £125 million Industrial Strategy Challenge Fund (ISCF) programme. This work was completed as part of the Air-One project (FFC grant number 75685) with lead partners Urban-Air Port and project partners Small, Malloy Aeronautics, Coventry City Council, Coventry University and Hyundai Urban Air division.

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The Relative Importance of Social Cues in Immersive Mediated Communication

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Abstract. Effective interpersonal communication is important to maintain relationships and build trust, empathy, and confidence. In this digital age, communication has become mediated, which filters out many of the social cues that are essential to facilitate interpersonal communication. This paper investigates the extent to which social cues influence social presence in mediated, bidirectional, multiparty interaction. Literature related to six social cues – paralinguistic cues, linguistic cues, body language, eye movements, facial expressions, and proxemic cues – was reviewed. These cues were ranked based on how relevant they are in creating a sense of social presence in mediated social communication (MSC). The most relevant cue was eye movements, followed by facial expression and linguistic cues, and lastly, body language and proxemic cues. Paralinguistic cues could not be ranked due to sparse literature in the context of MSC. Further research is required to better understand how social cues can be incorporated into MSC systems.

Keywords: Social cues · Social presence · Virtual reality · Social VR · Remote communication

1 Introduction

We, as humans, have a basic need to communicate with others to maintain interpersonal relationships [1]. Effective interpersonal communication relies on more than only an efficient exchange of semantic content. Emotions, which form a large part of interpersonal communication [1], are mainly communicated through nonverbal behavior like facial expressions, intonation, touch, and gestures [2]. In today's digital age, this communication has become increasingly mediated. With the rise of computer graphics and communication technologies, we are getting closer to bringing mediated communication at par with real-life communication in the visual modality.

To allow mediated social communication (MSC) to afford the same affective characteristics as face-to-face (F2F) communication, MSC should be able to elicit a sense of social presence [3]. Social presence is defined by two key elements: (1) spatial presence and (2) social interaction [3]. Therefore, social presence is the sense of being together and interacting with other remote individuals in a mediated environment [4]. Social

© The Author(s), under exclusive license to Springer Nature Switzerland AG 2022
T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 491–498, 2022.
https://doi.org/10.1007/978-3-030-85540-6_62

presence is determined by the quality of direct mutual interaction [5], contextual cues, the telepresence (i.e., the feeling of being located in the mediated environment) qualities of the MSC, and individual user traits [6].

Contextual or social cues refer to verbal and nonverbal signals expressed through voice, face, body, or motion, and guide communication and other social interactions by influencing how we perceive and respond to one another. Co-presence, i.e. the sensation of being present in the same environment as other remote individuals in MSC, increases when individuals exhibit social interaction cues, even those as minimal as eye contact [7]. This, by extension, increases social presence. Social cues are diverse and complex but the ones relevant here are: (1) paralinguistic cues, (2) linguistic cues, (3) body language, (4) eye movements, (5) facial expressions, and (6) proxemic cues. This paper focuses on social cues perceived through vision and audition as opposed to olfaction and touch as the former are easily integrated into existing MSC systems, thereby generating a more extensive body of research.

Experiencing social presence in MSC involves a sense of intimacy (i.e., feeling connected with others during an interaction) and a sense of immediacy (i.e., the psychological distance between communication partners) [4]. Therefore, social presence is inherently bidirectional (i.e., involving a sense of mutual awareness) [8]. As such, this paper aims to answer the research question: *To what extent do social cues influence social presence in mediated, bidirectional multi-party interaction*? By reviewing current literature, first, the importance of social cues in facilitating social presence will be established. Next, the six identified social cues and how they influence mediated social presence will be explored. Finally, these cues will be ranked in terms of their effect on facilitating social presence in MSC.

2 Social Cues and Social Presence

Users of extended reality (XR, i.e., augmented reality, augmented virtuality, or mixed reality) based communication systems have the impression that their remote communication partners are physically present in their own real-world environment while users of immersive virtual reality (VR) communication systems experience being physically transported to another environment [9]. These systems can reproduce a wide range of social cues (visual, auditory, and sometimes haptic) and thus, improve social communication. Contrastingly, traditional communication tools like video- or audio-conferencing only transmit voice and non-verbal sounds, and partial two-dimensional images of communication partners, thereby filtering out many of the social cues essential for building trust, empathy, and confidence [3].

Additionally, the inability to transmit nonverbal cues can have a negative effect on interpersonal communication [4]. The presence of relevant social cues, in turn, increases social presence. Therefore, relevant social cues and other information about the shared environment need to be reliably conveyed in MSC systems. Nonverbal social cues create a sense of immediacy while conversations without such cues result in a “distant” interaction [10]. In other words, to provide communication partners a mutual understanding of each other’s intentions, mood, and feelings, it could be beneficial to unambiguously represent social cues in MSC [11].

The following sections will address the extent to which the six identified social cues influence social presence in MSC. These cues have been broadly classified into verbal, nonverbal, and other cues.

3 Verbal Cues

3.1 Paralinguistic Cues

Paralinguistic cues are social cues that are embedded in vocal communication but are separate from actual language or semantic content. This includes vocal pitch, tone, loudness, and inflection. In digital textual communication, paralinguistic cues could also include emoticons [12] or reactions like "likes" or "dislikes". However, for the purpose of this paper, these will not be considered.

Literature on the relationship between paralinguistic cues and social presence is sparse. However, one study [13] found strong evidence suggesting that voices that sound like an extrovert induce a greater sense of social presence than voices that sound like an introvert. Additionally, social presence increased when users heard voices that manifested a personality similar to their own. This indicates that while paralinguistic cues influence social presence, further investigation is required to understand their role in modern MSC.

Paralinguistic cues are present in most MSC systems, including the simplest ones like audio-conferencing. Thus, these are the most ubiquitous of all social cues. A better understanding of the relationship between paralinguistic cues and social presence could have important implications for the development of all types of MSC systems.

3.2 Linguistic Cues

Linguistic cues refer to the choice of words and structure of sentences, i.e. dialect and syntax, that users employ during communication. One study [14] investigated how verbal communication influences social presence in a mixed reality remote collaboration task. Participants completed a search task in a virtual large office. The researchers classified verbal communication between participants into four types of utterances: (1) social/emotional expressions (i.e., expressions of feeling), (2) acknowledgement (i.e., indication of listening), (3) complete reference (i.e., statements that could be understood on their own), and (4) reference pronouns (i.e., statements that used pronouns to refer to things).

In conditions with only verbal cues, participants asked for clarification whereas in conditions with verbal and visual cues (e.g., gestures), conversation patterns were more natural. Participants were also more confident and expressed positive feelings. These findings illustrate that while linguistic social cues are essential for MSC, they are far more effective when paired with other nonverbal social cues.

4 Nonverbal Cues

4.1 Body Language

Body language consists of two key elements: (1) body posture and movements and (2) head movements and hand gestures. While the former is subtle, less definite, and can

indicate some feelings and attitudes, the latter is deliberate and important to communicate meaning without words. Some examples of body posture movements are arm- or leg-crossing. Head and hand gestures could include movements like nodding, pointing, waving, etc.

In the context of MSC, the extent to which visual representations of communication partners behave like an actual person (i.e., behavioral realism) influences social presence [6]. Here, visual representations include but are not limited to two-dimensional images, avatars, etc. The positive effects of behavioral realism are stronger when the visual representation's behavior indicates awareness of its communication partner's presence. A research [15] found that participants felt increased levels of social presence when they interacted with a computerized agent (i.e., not a visual representation of another human user) that nodded at appropriate times than an agent that did not. While interacting with an agent is different from communicating with other humans, this research emphasizes that participants who thought they were interacting with an avatar representation of another human did not behave differently from those interacting with an agent. Behavioral realism influenced both sets of participants.

In general, users evaluate gestural solutions positively. Research found that users are more involved, aware, and socially present when hand tracking was used to create meaningful gestures [16]. Moreover, body and hand gestures were preferred over keyboard and mouse interactions. These findings show that behavioral realism in body language, especially with head and hand movements, is a strong predictor of social presence.

4.2 Eye Movements

Eyes are an important aspect of nonverbal communication. The morphology of the human eye has developed to enhance gaze perception [17]. The dark iris within a large, white sclera creates a high contrast, allowing people to follow each other's gaze [18]. Eye movements include looking, staring, and blinking. People also use eye contact to build trust; a steady gaze is usually perceived as a sign of honesty whereas a shifty gaze and an inability to maintain eye contact is seen as an indicator of deception.

Eye movements in MSC have also been widely investigated. In a study by [19], participants listened to a presenter in an immersive collaborative virtual environment. Eye gaze was transformed strategically to either be (1) reduced (i.e., presenter did not face either of the two listeners) or (2) augmented (i.e., presenter continuously looked at both listeners). In the augmented condition, each listener felt that the presenter was only looking at them. It was predicted that, due to increased engagement and social presence, the presenter would be better able to persuade the listener in the augmented gaze condition. This hypothesis was supported for female participants only. On an explicit level, female participants reported the problematic aspects of the augmented gaze like the unresponsiveness and unawareness of the presenter, and this also reflected in the self-reported social presence ratings. However, on an implicit level, they were still persuaded by the visual input of the augmented gaze.

These results suggest that though users recognize the issues of artificiality associated with transformed gaze, "personalized" gaze still has the intended impact in terms of inducing a sense of engagement and social presence. This study further highlights the extent to which gaze direction, on its own, can influence social presence in MSC.

4.3 Facial Expressions

The first social cue that we typically perceive is a person's facial expression. Facial expressions form a huge proportion of nonverbal communication. While other nonverbal social cues can differ among individuals, facial expressions conveying certain emotions like happiness, sadness, anger, and fear, are largely universal.

Eyebrow movements are a part of many facial expressions and are probably the most relevant of all facial gestures in conversations. For example, literature shows that eyebrow movements correlate with speech and happen during pauses in speech or to emphasize words or phrases [20]. Since eyebrow movements happen during both speech and pauses, they are not directly linked but rather the result of linguistic and conversational choices. At the same time, eyebrow movements of listeners reassure the speaker that they have their listener's attention. Eyebrow movements play an important role in maintaining attention, thereby facilitating a sense of social presence.

Similarly, research [21] also found that participants felt an increased sense of social presence when a virtual agent blushed after making a mistake during a presentation as this reflects behavioral realism.

5 Other Cues

5.1 Proxemic Cues

Proxemic cues refer to how we perceive the space around us. These cues are only generated when there are two or more parties involved in communication. Personal space is also a nonverbal social cue, which depends on factors like sociocultural norms, situational factors, individual traits, and familiarity.

A study investigating human-robot interaction [22] found that proxemic behavior exhibited by robots affected how socially present they were perceived to be. Specifically, participants considered robots that acted passively as more socially present than those who acted assertively. For instance, passive proxemic robots gave "right of way" in a path-crossing event, which could have led participants to perceive these robots as attending to them and their behavior and as considering the social rules of politeness. Thus, allowing users to establish and respect personal space in MSC could increase social presence. However, there are some issues associated with generalizing findings with non-human entities to human-human MSC. Some studies [15] indicate that the belief of interacting with either humans or non-human entities lead to no substantial differences in expectations or behavioral reactions. This suggests limited generalizability, but further research is recommended.

Likewise, [14] also found that while completing a search task, the remote user's spatialized voice guidance improved the local user's performance and sense of social presence in a highly cluttered virtual environment by providing auditory clues for spatial directions. These results further support the idea that proxemic cues like personal space and spatialized audio improve social presence by keeping the user engaged with the MSC environment.

6 Ranking of Relevance

Based on literature, it is evident that some social cues are more relevant to facilitating social presence than others. This section outlines a ranking of relevance for the social cues highlighted here and how this could be incorporated into the design of MSC systems. Since there is limited research comparing different cues or ranking the cues, this section is reflective of the interpretation of existing literature.

As seen in the previous sections, the most pervasive, and thus, relevant social cue for MSC is eye movements, specifically gaze direction. Therefore, to improve social presence in MSC systems, communication partners should be able to make direct eye contact and see each other's gaze direction.

Facial expressions are the next most relevant social cue, but they frequently correlate with linguistic cues. Thus, to further increase social presence, communication partners should be able to observe one another's facial expressions synchronized with their linguistic social cues.

Next, behavioral realism in body language and proxemic behavior was also essential for social presence. While it is more difficult compared to the previous cues to incorporate these into MSC, allowing communication partners to perceive each other's body language and proxemic behavior could exponentially increase social presence.

Finally, for paralinguistic social cues, while it does, to some extent, influence social presence, further research is required to specifically establish its importance in facilitating social presence.

7 Further Research

There still remain several questions about social cues in MSC that lie outside the scope of this paper. To better understand how social cues should be incorporated into the design of MSC systems, further research along the following avenues is required.

Firstly, there could be cultural differences in terms of which social cues are relevant and the way in which they are interpreted. Currently, most research related to social cues and social presence is carried out with users from Western cultures. Research with users from non-Western cultures is required to design MSC systems for those users that use different social cues to achieve social presence.

Secondly, social behavior like the display of social cues is determined by individual traits [6]. Designing MSC systems which disclose more social cues than current systems already disclose could influence the social behavior of users. For instance, some users who are accustomed to audio-conferencing might find it difficult to use MSC systems that project their body language and eye movements in a mediated environment.

From a technological design perspective, it is unclear how incorporating more social cues will influence the design of the MSC system itself. For instance, the system might become heavier or the user interface might become too complex, thereby deterring usage. Further research is required to carefully design MSC systems that incorporate multisensory social cues.

Finally, the interplay between different social cues needs to be studied further. Social cues could have an interaction effect. This was briefly addressed in the previous sections. For instance, [23] found that speech included turn-taking and back-channel signals,

which were given through eye contact and head nods, respectively. This indicates that linguistic cues, eye movements, and body language often interact in social communication. Deeper research is required to understand how such interactions could influence the design of MSC systems.

8 Conclusion

This paper identified and reviewed literature related to six key social cues: paralinguistic cues, linguistic cues, body language, eye movements, facial expressions, and proxemic cues. These cues were ranked based on the extent to which they are relevant in creating a sense of social presence in MSC. The most relevant cue was found to be eye movements, followed by facial expression and linguistic cues, and thirdly, body language and proxemic cues. Paralinguistic cues could not be ranked due to sparse literature in the context of MSC. Avenues for further research are recommended to better understand how social cues can be incorporated into MSC systems.

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Impact of Weather and Pollution on COPD-Related Hospitalizations, Readmissions, and Emergency Visits by Integrating Claims and Environmental Data to Build Human-Centered Decision Tools

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Abstract. Chronic obstructive pulmonary disease (COPD) is the third-leading cause of death in the U.S., particularly impacting elderly populations (*Learn about COPD*. American Lung Association.). In this study, we integrate advanced machine learning methods with health patterns, environmental exposures, and patient outcomes, identifying the value of human-centered decision making tools. With the aim of reducing the negative effects of COPD at a zipcode level, this research investigates how risk variables such as age, sex, underlying conditions, and environmental exposures impact 30-day hospitalization, readmission, and emergency visit rates in New York, Pennsylvania, and Florida – urban areas that experience high annual rates of hospitalization. Our aim is to help patients preemptively prevent exacerbations of COPD by providing clinicians with visual tools to anticipate environmental changes so that they can offer more timely care to vulnerable populations. This study found that weather and pollution have strong impacts on COPD-related hospitalizations and ER visits and a moderate effect on 30-day readmissions.

Keywords: Human-centered design · Human-systems Integration · Environmental exposures · Data analytics · Human factors

1 Introduction

Chronic obstructive pulmonary disease (COPD) is the third-leading cause of death in the U.S., affecting diverse populations across the US, especially the elderly.[1] With the aim of reducing the negative effects of COPD at a zipcode level, this research investigates how specific risk variables such as age, sex, region, comorbidities, and environmental indicators impact 30-day hospitalization, emergency room (ER) visit, and readmission

[1] *Learn about COPD*. American Lung Association.

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 499–505, 2022.
https://doi.org/10.1007/978-3-030-85540-6_63

rates in Florida, New York, and Pennsylvania. Previous studies have shown that air pollution can have chronic implications on the development of COPD among adults. Our methodology further advances this research by comparing the risks of distinct COPD-related outcomes using different machine learning methods and approaches. We integrate data science methods with environmental exposures as well as medical patterns and outcomes, underscoring the value of human-centered decision-making tools. Our aim is to help patients preemptively prevent exacerbations of COPD by providing them and their clinicians with visual tools to anticipate environmental changes as well as to enable medical providers to offer timely care and support to more vulnerable populations, especially the elderly. By examining pollution levels and external indicators in metropolitan regions, our research investigates the intricate relationship between urbanization and human health in civilian contexts. Taking a human-centered design approach, we examined more than 200,000 distinct patient episode records. Our study used 2017–2018 CMS clinical and operational claims data (CMS Medicare and Medicaid) for adult COPD patients in addition to daily zipcode-level pollution and weather conditions. In this study, we identify and examine the relationships that exist between factors such as hospitalization, ER visit and admission, and readmission rates and individual patients' clinical information as well as seasonal external data. To extrapolate from our data, we created predictive models such as logistic regressions, boosted tree classifiers, and deep neural network (DNN) models, which we used to predict patient outcomes given patient demographics, clinical history, and environmental exposures.

2 Study Design

Our analytical database includes de-identified adult CMS claims, temperature, precipitation, and pollutant measures for NO2, PM2.5, PM10, SO2, CO, and O3, which we sourced from the EPA and NOAA. Regarding our model selection, we utilized standard models to test logistic regressions, used XG Boost for our boosted tree classifiers, and based our DNN models on GCP and R Statistical Packaging. We created models

Table 1. Study design variable details

Sex (M/F)	M/F (55% / 45%)	M/F (55%/45%)
N = Over 3 years' worth of patient records	70% for training (modeling and functional feature extraction)	30% for validation and cross-validation
Age-groups	18–65	18–65
• Outcome Variables	Hospitalizations; ER Visits; 30-day Readmissions	Hospitalizations; ER Visits; 30-day Readmissions
Features	Age, sex, acute care history, comorbidities, and daily zipcode-level pollution, temperature, and precipitation data	Age, sex, acute care history, comorbidities, and daily zipcode-level pollution, temperature, and precipitation data

for each state for cohort similarity. The dominant factors include demographic data, comorbidities, pollution levels, past history of hospitalizations, and abnormal weather conditions.

Our data focuses on three major urban areas and highly populated states, namely New York, Pennsylvania, and Florida, which each experience high annual rates of hospitalization. As seen below in Table 1, we considered 70% of our data for training purposes and 30% for validation and testing, also cross-validating our results for verification purposes. We used BigQuery ML and R Studio to develop our models. As can be seen in Table 2, we examined the distinct performance of each of our predictive models based on variance and bias criteria.

Table 2. Model performance comparison

Model Type	Model Performance Consideration
Logistic Regression	Low variance; moderate bias; low overfitting
Deep Neural Network (DNN)	High variance; low bias; high overfitting
Boosted Tree Classifier (with XG Boost – *Google Cloud*)	Low bias; moderate to high overfitting

2.1 Predictive Models for COPD Populations Across FL, PA, and NY

In Fig. 1, the ER Admission Risk (Florida) ROC plot is shown. The logistic regression model (ROC) displays 78% accuracy. In Fig. 2, the 30-Day Readmission Risk (Florida) ROC plot is illustrated. This logistic regression model displays a low 60% accuracy. In Fig. 3, the model demonstrates a high accuracy level for hospitalization risk in Florida. We sourced hospitalization data from community, home health, and outpatient settings. The F-measures for the three models are 0.95, 0.29 and 0.88, respectively.



Fig. 1. ER Admission Risk (FL)

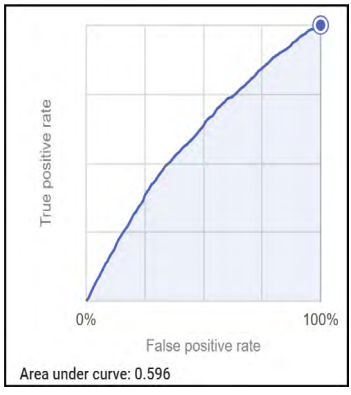


Fig. 2. Readmission Risk (FL)



Fig. 3. Hospitalization Risk (FL)

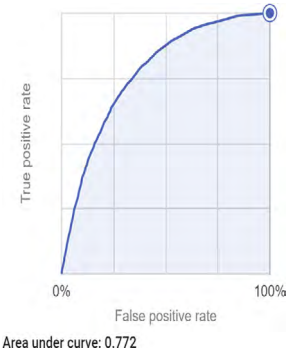


Fig. 4. ER Admission Risk (PA)

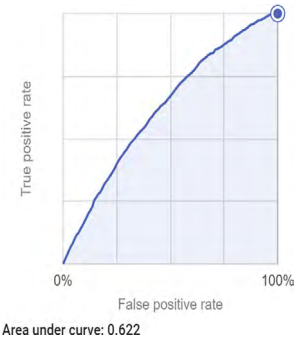


Fig. 5. Readmission Risk (PA)

Figure 4, the ER Admission Risk regression model for Pennsylvania, displays 77% accuracy. Figure 5, the 30-Day Readmission risk model for Pennsylvania, displays 62% accuracy. Figure 6, the logistic regression model predicting hospitalization risk in Pennsylvania, shows 89% accuracy. The F-measures for the three models are 0.96, 0.27 and 0.81, respectively.

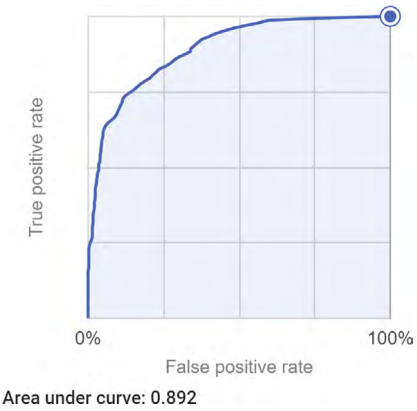


Fig. 6. Hospitalization Risk (PA)



Fig. 7. ER Admission Risk (NY)

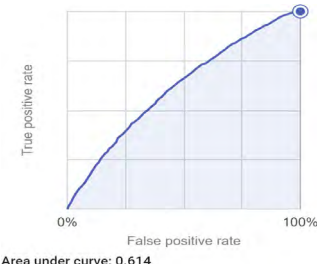


Fig. 8. Readmission Risk (NY)

Figure 7 illustrates the ER Admission Risk for New York. This logistic regression model displays nearly 78% accuracy. Figure 8, the 30-Day Readmission Risk for New York, displays over 61% accuracy. Figure 9, the Hospitalization Risk model for New York, displays over 91% accuracy. The F-measures for the three models are 0.96, 0.28 and 0.80, respectively.

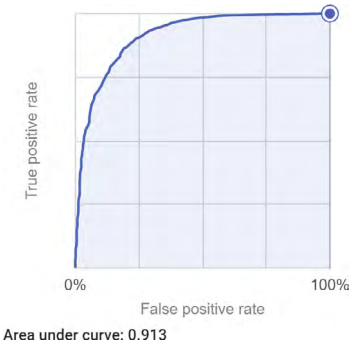


Fig. 9. Hospitalization Risk (NY)

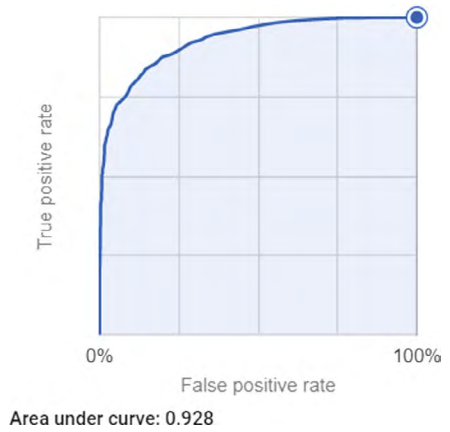


Fig. 10. *Deep Neural Network*: Hospitalization Risk (NY)

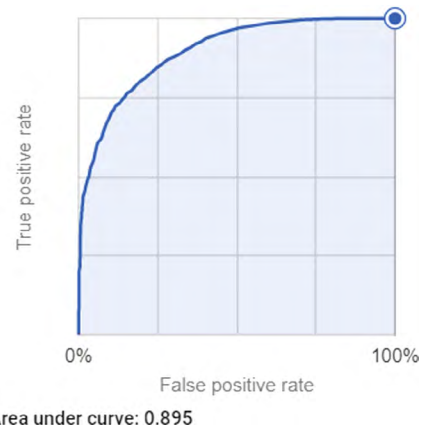


Fig. 11. *Boosted Tree*: Hospitalization Risk (NY)

3 Model Comparisons

To delve deeper into the risk of hospitalization in NY State in particular, we compared our measurements for NY Hospitalization Risk using three different predictive models. For logistic regression, we achieved a 91% AUC, 93% accuracy for our Deep Neural Network model (DNN), and 90% for our Boosted Tree model (see Fig. 10 and 11).

4 Conclusion

Our research findings indicate that weather and pollution have strong impacts on COPD-related hospitalizations and ER visits. The impact on 30-day readmissions is moderate. In the urbanized regions of New York, Pennsylvania, and Florida, certain environmental triggers, such as unusual levels of PM2.5, PM1.0, SO2, NO2, CO, and O3 in addition to cooler temperatures and high levels of precipitation and particulate matter, make patients of all age groups especially susceptible to being hospitalized or to receiving acute care for COPD-related causes. Our risk models, which combine clinical information with external indicators, can identify, and in turn alert, both vulnerable patients who inhabit regions impacted by high pollution levels that can aggravate COPD as well as hospitals in regions with larger vulnerable populations. We hope that our research will inform the work of public health groups (case managers), hospitals (care managers) and primary care groups (and GPs) as this data can predict patient outcomes and provide timely information to both clinicians and care providers.

5 Future Studies

In the future, we could create new analytical models that examine patient socioeconomic factors (e.g. income levels) and habits (e.g. tobacco use) in addition to environmental

exposures, demographics, and underlying conditions. We could next also predict COPD prevalence in highly metropolitan areas along the West Coast to examine if factors such as wildfires or other routinely occurring natural disasters play key roles in the development of respiratory conditions of patients in these areas. We would ensure that our next research study would still examine one of the crucial underlying issues of our work, which is the social factor involving families living in low-income neighborhoods who are often those most affected by COPD. Our research, we believe, has the potential to help identify and alert patients who could then seek out affordable medical care and support at an earlier point.

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Digital Model Construction of Sports Technology from an Animated Perspective: Taking Basketball Techniques as an Example

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Abstract. The existing physical education is limited by the characteristics of text media and spatial dimensions. Many technical teaching contents are taught only through language description and basic action demonstration, making it difficult for students to understand the main points and theoretical basis of action. The application of digital media language in physical education teaching, the application perspective of interdisciplinary subjects, the application analysis of animation in sports technology enriches the construction of the digital teaching material system of sports technology, promotes the construction and development of sports disciplines. The animation interpretation of basketball technology vividly presents the components of basketball technology, promotes the development and perfection of basketball theory, and the construction of the digital model is conducive to students' in-depth understanding of teaching knowledge. Digital technology will give traditional teaching a more comprehensive perspective and interpretation so that in the digital age to find a better way to integrate with digital technology, improve teaching content, and promote the development of disciplines.

Keywords: Human factors · Physical education · Animation interpretation

1 Introduction

Through the in-depth study of multi-disciplines such as the theory of physical education and physical education, clarify the necessity and essential significance of digital model construction in sports technology teaching, and found animation technology and physical education more effective as in basketball technology teaching. Combine points and application forms for the subsequent digital tutorial production, the necessary theoretical support and guidance are provided to provide a more comprehensive analysis of the theory and practice of sports technological teaching and integrate the characteristics of digital technology into the discipline of physical education. To a certain extent, it carries on the frontier exploration to the related disciplines; The students' learning perspectives are diversified, the learning effect and quality will be significantly improved, and the classroom teaching methods will be more abundant and effective. The digital procedural approach to the modeling of animation production will be extended to any sporting, technical element of action.

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 506–513, 2022.
https://doi.org/10.1007/978-3-030-85540-6_64

2 Method

At present, the research is mainly carried out through literature and investigation. No matter which kind of social activity wants to leave a permanent trace, it is inseparable from various literature. Human activities and the contradiction between the finances of individual life and understanding have determined that we must use the literature when we have passed the facts. For thousands of years, rich education literature has accumulated countless relevant educational facts, data, theory, methods, and scientific hypotheses and ideas and become a valuable spiritual wealth of human beings. As an educator, advanced and use literature can better conduct educational teaching research, excavate human spiritual treasures, reveal the development of education, and develop our education. From a time point of view, the literature method is a "historical" study. Whether it is ancient literature in the past five thousand years or is still modern and today's literature, if it results from the current research, researchers can study. However, the historical characteristics of the literature method are relativity, which is the history of yesterday relative to today. From an operational perspective, the literature method is not affected by time and space, and it has considerable flexibility. Suppose the literature research cannot be visible to the scene. In that case, it is not subject to the education environment, schools, work plans, students, teachers, parents, and other factors. In time, it can also be studied at work time and can also be at work time. Research, teachers can also use cold summer vacations, researchers can arrange the time, or have a few days, or have accumulated months.

To study a specific educational problem indirectly, basically without the limitation of time and space. It is impossible to observe all educational phenomena directly in educational practice, and it is impossible to study all educational phenomena experimentally. With an investigation method, objective education phenomena (or reality) can be described and explained. education as a social phenomenon is omnipotent, complicated, and more varied. To study it, you have to investigate research, become an orderly, variable blurry is clear, form a holistic profile in mind to carry out correct evaluation and judgment. Because of the above characteristics of the educational survey method can be used to study educational phenomena with a wide range, an enormous scope, and a long time, such as students' learning motivation, learning interest, and learning effect, and students' career orientation and values. Through interviews and surveys, this paper understands students' feelings towards traditional physical education teaching and their views on introducing the digital model into teaching, providing ideas for the subject research. According to the existing research data to further complete the theoretical research.

3 Necessity

Today, user experience is one of the essential dimensions that affect the user;s feelings, has become a critical driving force that promotes the development of the product. This topic introduces innovative new media technology into the physical teaching process, dramatically enriches learners' use, and optimizes learning effects by enhancing user experience in teaching. The development of information technology has enabled

information products to be widely used in social production and people's lives and has played an essential role in promoting social effectiveness and the convenience of increasing people's lives. Information technology promotes social development and essential tools in the renovation of society, software design work and development work should be regarded as an essential basis. It should be multi-station to consider multiple users. To meet the user's demand as the first goal, try to avoid problems after the software is launched. In software design and development, software designers and developers often pay attention to software functions but have not emphasized users' experience. In turn, the software function has not attracted enough attention, but this factor plays a role in determining the design and development of the product. The emphasis on the user experience is conducive to improving the evaluation of the software itself and conducive to the development of software design and development. It can have more straightforward design ideas, ensuring that software design and development work have a good development direction.

Media Environment. Marshall McLuhan pointed out: "Media technology tends to create a new environment, which makes the old media obsolete and affects people's social behavior. "In the era of rapid development of digital technology, traditional teaching has been profoundly affected. Physical education is an essential part of quality-oriented education. The application of digital technology plays a positive role in promoting physical education reform, establishing new teaching concepts, transforming teaching methods, and improving teaching quality. Media is the message. The digital age means the broad application of digital technology and indicates that digital thinking is affecting people's sensory behavior. When people's sensory thinking is affected by the new media language, traditional physical education and written textbooks need to find a suitable technical carrier for the digital age.

Physical Education. In his Theory of Competitive Sports, Beckmann pointed out that necessary intuitive factors should be guaranteed in athletes' training to form clear visual perception and its representation based on it. At present, virtual and MOOC information technology is widely used in the teaching of physical education. However, there is a lack of specific technology display in digital textbooks, movement performance analysis, and other aspects. In class, teachers and students cannot express the internal physiological mechanism and technology elements in words, affecting students' cognition and technical action output.

Cognitive Learning. Neil Postman pointed out that "the changes of media environment have influenced the thinking patterns of human beings in different eras and created cultural content in different eras [1, 2]." With software technology development, production tools such as Retas, 3D Max, Maya, Animate, and Cinema 4D have endowed animation technology with a richer medium language. As a media metaphor, the animation uses dynamic digital graphics as the narrative language to deconstruct the old thinking and cognition. It endows the old things with new interpretations and interpretations through unique visual expression. This project aims to study the construction of the digital model of sports technology from the perspective of animation, analyze and compare the characteristics of digital technology through media language, and explore its influence and significance on physical education [3].

User Experience. Psychologist Donald Norman proposes to meet the user-centered design concept, which is gradually developed into a "user experience" that is currently more concerned [4]. ISO 9241–210 standard defines the user experience as "all the feelings of users before using a product or system, using all the feelings after use, including emotions, faith, well-known, cognitive impression, physiological and psychological reactions, behaviors, and achievements [5].

4 Value and Significance

The concept of animation is different from the monologues cartoon. Animation is a comprehensive art collection of artistic performances such as painting, movies, digital media, photography, music, and literature. The earliest issued from the first half of the 19th century, prosperous in the United States, China animation originated in the 1920s. Animation is a young artist. It is the only art that has the date of determining the date of birth. On October 28, 1892, Emir Renault's first time in Paris, the famous Geki Fan Wax Museum, shows the audience, marking the animation. Formal was born, and Emir Renault was also known as "the father of animation" [1]. Animation art has been developed for more than 100 years, has a relatively complete theoretical system and industrial system, and is deeply loved for its unique artistic charm. Animated English has many expressions such as Animation, Cartoon, Animated Cartoon, Cameracature. Among them, the word "Animation" is derived from the Latin root Anima, meaning :soul," verb Animate is the meaning of "giving life," which is intended to make something to live. Animation can be defined as the use of paintings, creating the art of life sports [6, 7].

The Characteristics of Animation and Physical Education. Mellen Dressler pointed out that the animation as a generalized dynamic visual symbol of abstract and image instructions, covering the message from the abstract into all possible images, fully fused with the new media audiovisual function, meets different "temperatures." The dissemination demand is mobilized to sensory, and thus has become the most representative research object of new media. "Animation Symbol" will become the primary symbolic resource of future media development due to its freedom and vast extension space. The existing sports technology animation is mainly in the dynamic trajectory trend and enhances classroom fun. It has not fully utilized the unique media language of the digital animation model, and there is a particular vacancy and shortcomings in theoretical significance.

Technical Features of Animation. Animated shooting adopts "Class-Team" technology, a series of people are drawn, through a one-year-old (frame), recorded on the film (or tape) and 24 Board (or 25 frames) is annoying to screen on the screen, enabling the image of the created to gain a lifelike activity. Shooting frame by frame is the crucial technology of animation, and it is also an important symbol that makes animation different from other films and videos. Through the decomposition of the moving process and shape of things, the animation draws a series of different instantaneous movements in the moving process. It then carries on the processing technology such as picture by

picture, sequence coding, time calculation, and shooting one by one. In traditional physical education teaching, the analysis of a particular technology is mainly based on the demonstration and narration of the teacher's actions. The standardization of the action schematic and the accuracy of the language expression significantly affect the audience's understanding of this technology and grasp the key points. The animation production dissects the motion into a sequence of static frames and draws them one by one, which helps the audience clarify the style of movements at each time point. It can roughly feel the trend of movements and analyze the changes of movements in detail and understand the technical gist. In terms of some sports techniques, the mastery of rhythm is also the key to skill acquisition. However, in the traditional sports teaching demonstration, it is difficult for the teacher to control the stable output of the rhythm of the movement. To solve this problem, the animation can reflect the rhythm of the movement by adjusting the frame rate during the production process, which can effectively solve the problem.

The Modeling of Animation. All the images, including roles or backgrounds, are shaped using model art tools, exaggerations, exaggeration, deformation, emblem, and symbols. Its image structure is the visual operation of the art modeling element. The role is designed with the background of the image, whether it is a flat painting design or three-dimensional images and cannot be separated from the art category. Therefore, art is the foundation of animation image design and director creation, and shape is one of the fundamental characteristics of animation. In traditional sports teaching, the analysis of technical action lacks vividness and cannot ensure that the audience accurately receives information from the subsequent action demonstration and language expression. Exaggeration in animated modeling, extreme expressiveness such as deformation can bring a visually solid, strong stimulus, emphasize the critical points of highlighting technical movements, clarifying structures and modes, and deepens understanding. The impact of visual language expands to a certain extent and vividly exhibits sports techniques.

The Presumption of Animation. Animation in the image is artificially created, which is the creator has assumed design, including the role hypothesis and the scene hypothesis. The presumption of animation determines that the techniques such as exaggeration and deformation occupy a unique position in the artistic creation of animation. It can make some strange and bizarre actions that people cannot even imagine in real life with its unique expression and appeal without restraint. The image vision of animation is the hypothetical artistic image of activity and the comprehensive visual expression in the hypothetical plastic art space. The presumption and modeling of animation are important animation principles to make up for the limitations of traditional physical education. The impart of sports technology is limited by many factors in the reality of traditional sports teaching. To a certain extent, the presumption of animation can release the sports expression constrained by the dimension of time and space.

The Synthesis of Animation. Animation is an emerging discipline of emerging science, skills, and art. Its generation, existence, and development involve the articles such as drama, literature, art, music, etc., and integrated into many scientific and technical means such as photography and computers, one of the unique integrated disciplines and unique integrated art forms combined with art and science. The creation and production

process of animation is a comprehensive process of various art categories and science and technology. From the perspective of sports teaching macro-development, the subject cross has become an inevitable development trend in the education era. Sports technologies are no longer a single-action model to teach but integrate biomechanics, sports medicine, and others multi-door scientific research. The internal functionality and the comprehensive integration of animation can give it a richer expression, bringing a new perspective and physical education teaching.

5 Preliminary Exploration of Animation Model

Analysis of basketball technology needs to follow scientific research in sports mechanics, sports physiology, human muscle anatomy, and the construction of animation models based on specific analysis of exercise trends, the origin of force, joint movement, muscle changes [8]. The movement trend mentioned here can be understood as the tendency of movement and the state of movement, that is, the description of the direction of movement, the trajectory of movement, and the starting and ending points of movement, and it is also a perspective to grasp the overall sports technology. Take the movement of the elbow during shooting as an example. In this technique, the elbow movement can look like an arc, and the elbow is pushed forward and upward by the force of the arm. Understanding the movement trend is conducive to the overall grasp of a particular sport technique. Force sequence refers to force transmission, which shows the sequence of different muscles in a particular technical movement and the relationship between these forces. Take shooting as an example. First, the ankle joint works with the waist and buttocks to transmit the force to the upper limbs through the arm, and finally, the ball is thrown. The sequence of exertion is one of the essential theoretical knowledge in any sports technique. Only by mastering the sequence of exertion can we better understand the critical points of the technique and bring about better sports performance. Muscle changes refer to the deconstruction of the function of each part of muscles in the teaching of physical education techniques. Take the change of biceps and triceps during shooting as an example. In preparation for shooting, the biceps contract and the triceps relax, and then the triceps contract and the triceps relax to throw the ball.

Two-dimensional model construction is related to traditional animation, mainly on Photoshop and Animation two software. Two software-equipped withdrawing and designers can choose the right design tools by their preferences. We have to clearly and draw the images. The overall idea is to split a complete action into a frame-static picture, adjust and modify the critical screen as needed, and finally synthesize new motion images. First, we open Photoshop, pick the critical nodes in action, the original painting refers to the keyframes, and the selection criteria can be done by the actual needs of the motion trend, the origin order, muscle changes, etc. After picking out the keyframes that need to be drawn, we start drawing with the brush tool. Here it is recommended to use the tablet board. Select the appropriate brush and adjust the nip to 0, outline the outer contour, complete the color fill so that the image has a volume. After getting the original image, we started to draw an intermediate painting based on these keyframes, namely, draw its motion change path.

The construction of the 3D model is mainly completed by two software, ZBrush and Maya. The overall idea is to use ZBrush to carve the model and then use Maya binding to generate animation. First, we use the polygon whole to summarize the body so that the wiring is uniform and clear structure trend, but also consider the cloth line should be easy to adjust the movement. General 3D software is the point, line, and surface adjustment, and poly after the commonly used command is not much, add line commands such as cut, connect connection; Merge commands such as weld, target weld and collapse disconnect commands such as break, chamfer, etc. Extrude commands such as extrude, inset insert; Delete commands such as delete, remove. Polygon modeling mainly depends on the generalization ability of the polygon, the grasping ability of the sense of the whole, and the grasping ability of the proportion relationship. Recommend Silo modeling here because it has many shortcuts, and many functions are easier to operate. There are three main modeling methods: global addition and subtraction line modeling, local surface extruding modeling, standard model modification. During this process, pay attention to check whether all the points of the model are welded. If some points are not welded, the ZBrush will be deformed. Like sculpture and painting like expression, it is best to use ZBrush to do a high model. Adjust the user interface for easy operation. Use the digital board to operate, use shortcuts, press and hold the space bar to adjust brush properties so that the operation is simple, direct, and practical to improve the speed. The polygon modeling may not be very accurate in some places. After the high model is molded, the subdivision level is minimized, and the accurate low model can be obtained by exporting it. The core of ZBrush is the brush, Alpha, topology. The surface of the regular vertical line is flat, which is very good for laying the line. The clay brush is great for adding subtle volume. The standard brush Standard is excellent for just starting with big shapes. Modify the brush: move the brush to adjust the characteristics often used. Magnify the brush to enlarge the object locally. The pinch brush pinches an object locally. Smooth brushes like melted objects can achieve a specific smooth effect but pay attention to the subdivision level and strength of the connection. Alpha adds detail by mapping grayscale images onto the model, black for no mapping, and vice versa. Topologies can obtain a low module from a high module topology while preserving the high module information. The advantage can rewire, at the same time, play the role of surface reduction. But only one object topology, some inconvenient. Note that ZBrush's coordinate system is not very good.

6 Discussion

Animation is in-depth research combined with digital art and sports disciplines in developing digital technology iterative development. The diversified perspective of interdisciplinary is different from the bias of a single scientific study and combines the overall and partial closely. The research issues are in the full range of in-depth profiles and arguments. This project is based on theoretical significance as the primary research direction and combined with the practical digital model design and construction of some basketball technologies while forming academic papers. While playing theoretical guiding significance, it also promotes theoretical research through practical application. Deep, avoid emptying and pre-judgment. In existing research, most of the analysis and argument of

shallow levels did not answer the necessary sexual problems such as animated digital models in sports technical teaching, theoretical research, theoretical research. This topic project will integrate the theoretical research of relevant disciplines, analyze and explore, fill and improve the lack of existing theoretical research, and promote discipline.

Although both animation media and sports technology teaching have a long history of development and research, the construction of the digital model of sports teaching technology from the perspective of animation discussed in this topic is put forward in new media technology. With the rapid development of society and economy, China began to pay attention to and promote innovative design. As one of the directions of innovative design, user experience design has gradually become a hot topic. The core of user experience is human-centered design, which focuses on meeting users' needs to use products and their feelings during the use process. Combining new media technology with the physical education teaching process can make full use of the high interactive advantage of new media itself and improve students' sense of immersion and experience in the learning process.

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Mapping Risks and Requirements for Truck Platooning: A Human-Centred Approach

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Abstract. The concept of truck platooning comes from the virtual linking of two or more trucks driving on the road in convoy, with a short distance between them. These vehicles keep the distance using SAE level 2 or 3 automated driving technology supported by a Cooperative Adaptive Cruise Control system. The first truck is considered the leader and the following truck(s) react(s) and adapt(s) their speed and position on the lane without human action.

The TRAIN project addresses these issues through a Human-Centred approach to identify requirements for the development of truck platooning technology and assesses risks towards a safe deployment in the real world. Following the collection of qualitative data from experienced truck drivers, tests in a driving simulator will allow for identifying risks related to the drivers' activity in truck platooning.

Finally, design and operational guidelines highlighting the importance of human-system integration in the system development will be issued.

Keywords: Freight transport · Truck platooning · Driving automation · Human-driving simulator testing · System integration

1 Introduction

The continuous and intensive technological development towards automation highlights the needs for deep research, particularly in what concerns human factors issues. Additionally, the promotion of specific actions targeting public awareness on the new risks introduced by vehicles with some level of automation should be developed instead of some irresponsible dissemination and advertising about automated vehicles. Thus, specific actions towards public awareness on new risks introduced by automated vehicles on the shared road, together with relevant information and higher-level education programs towards the appropriate use of automation, together with the prevention of risky behaviours and avoidance of misuse and disuse, should be planned and executed. Furthermore, the automotive industry is also targeting the freight transport and innovative

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 514–522, 2022.
https://doi.org/10.1007/978-3-030-85540-6_65

solutions for decarbonization, road safety improvement and health issues addressing professional truck drivers and their working conditions and related constraints. Thus, automation appears as an appropriate solution, particularly the introduction of truck platooning for efficiency improvement in the European freight transport market. However, this is totally new and requires deep research in order to avoid compromising road safety by the introduction of new and unexpected risks.

The concept of truck platooning comes from the linking of two or more trucks driving on the road very closely in convoy. The first truck is considered the leader and the following truck(s) react(s) and adapt(s) their speed and lane position without (or very little) human action, using automated driving and vehicle-to-vehicle communication technologies. These vehicles keep the distance using automated driving technology and radar-based collision avoidance system, as well as connectivity technology with wireless vehicle-to-vehicle communication (V2V) allowing for communicating between them [1]. According to scientific publications in the domain and the intensive advertising, the automated and coordinated movement of truck platoons reduces fuel consumption, CO2 emissions and traffic jams, but most important, improves road safety and drivers' working conditions.

Truck platooning is a totally new technology requiring deep research in order to develop awareness about new risks and prevent from their undesirable effects on road safety. In Portugal, very few research projects centred on truck platooning have been or are being developed despite their particular and new conditions on the road, on the interaction with other road users and the particularity of two different but complementary driving tasks. Thus, such lack of knowledge and experience about this freight transport system, require the development of knowledge, the specific drivers' training and the promotion of the required awareness about truck platooning. Thus, the TRAIN project addresses these issues through an integrated approach to identify the requirements for the development of truck platooning technology and assess the risks for a safe deployment in the real world. In a first stage, TRAIN is engaging professional truck drivers and representatives of freight companies in the collection of qualitative data aiming at identifying their knowledge, perceptions, opinions and feelings about autonomous driving, and particularly, truck platooning. The results from these activities will allow to (i) assess drivers and companies' awareness on truck platooning technologies, and (ii) provide inputs to design and tune experimental scenarios in driving simulator on the basis of the identified risks.

Finally, TRAIN will deliver guidelines to the platooning industry highlighting the importance of human-system integration since the early stages of the system design and development, as well as training and operational recommendations to stakeholders towards drivers' acceptance and behavioural models. Such project outcomes will reflect a comprehensive mapping of risk factors and training needs towards a safe and acceptable deployment of truck platooning on public roads.

2 The Freight Transport and Truck Drivers

Technical and organizational conditions provided to truck drivers by freight companies in most developed countries are recognised to impose heavy workload and stress, frequently accompanied by passive fatigue, which leads to drowsiness and increased risk

of crashing. A study developed in the Netherlands [2] found a relationship between job related role stressors and three components of burnout. This study collected qualitative data from truck drivers in two waves with an interval of two months: 534 for the first wave but just 214 completed the survey on the second wave. In the first wave, the different potential causes of burnout were measured (role conflict, role ambiguity, quality of sleep, and the perceived emotional intelligence of the dispatcher). In the second wave, the three elements of burnout were measured (emotional exhaustion, depersonalization, and low personal accomplishment). The results of this study indicate that the role conflict relates positively to all the three components of a burnout and are influenced by sleep quality, which has an impact on depersonalization and emotional exhaustion. Despite some limitations of the study, particularly the number of participants in the second wave and the short time lag between both waves, the authors conclude that the identified working constraints are common among the trucking industry.

Another study based on a survey carried out in France with 515 truck drivers from eight European countries has highlighted their poor quality of sleep and the related probability of occurrence of near crashes related to fatigue, near crashes in general, and/or crashes [3]. Furthermore, a poor health state along with tobacco habits and unbalanced diet have been reported. These results are in line with others issued from prior investigation to this one. The reported truck drivers' risk taking behind the wheel, as well as road risks, together with sleep quality, seem to be linked to distress at work, the latter being especially triggered by certain working conditions (driving on roads in lousy state, problematic truckloads, long working hours, annoyances during rest periods, etc.). The reported risk exposure is associated with poor skills at manoeuvring, particularly in lousy road conditions in relation to the vehicle size, anticipation of danger, keeping safe distance with the vehicle in front, driving downhill, coping with fatigue, and with dangers on the road, with underestimation of the difficulties linked to blind spots in the mirrors, braking while driving downhill, handling sharp bends, driving in bad weather conditions (rain, snow, strong winds), all this coupled with the lack of a desire to develop one's skills during mandatory training [3]. Such picture requires urgent solution towards the improvement of working conditions for truck drivers in general. Truck platooning could represent a positive evolution for the sector and truck drivers, but there is much to improve in the truck industry culture and mainly, at the level of truck drivers' working conditions.

So far, platoon systems operate at level-1 or level-2 automation, which corresponds to the following conditions: the leading driver is monitoring the surrounding conditions together with the platooning system in case of a take-over request [4]. A large-scale deployment of fully automated vehicles (level 5) on public roads is not yet predictable. Until then, vehicle automation, and truck platooning in particular, will pass through intermediate development stages [5]. According to European and North American authorities [6, 7], the first truck platoons have been deployed on public roads in the current decade using level 2 automation for the leader and the followers, or eventually level 3 for the followers. This means that the leading driver is taking control of, at least, the vehicle dynamic activities, supervising the automated driving task in order to promptly respond to any request to intervene.

Another problem is that, so far, there is not a transversal policy towards a public awareness and an understanding about automated driving, the automation levels and the practical meaning of each one. On the contrary, there is a massive advertising on self-driving cars using unrealistic and unsafe images. The total ignorance by potential users of this type of vehicle about the technology that makes it up, how it works, their role in the driving task performance or the impacts of a full automation, gives rise to an overreliance on the system, underlying further risky behaviour [8]. For Popken et al. [9], the overreliance and the change of task priorities reflect major safety concerns. User's acceptance and trust, avoiding risky behaviour resulting from overreliance or lack of trust, should be prevented as well.

3 The Risks and Limits of the Technology

The increasing needs for digital knowledge and understanding of the technology use and functioning are nowadays main requests for safety when driving a vehicle with some level of automation in a road environment shared by an enormous variety of road users. Driving a vehicle involves risk-taking, which requires risk awareness and some experience towards appropriate and safe decisions. A major request for a safe and effective use of a technological innovation is its maturity, which is composed of: (i). the technology maturity, represented by its robustness, stability, controllability and observability; (ii) the maturity of practice, represented by potential users' intention of using it and their related reactions; (iii) and the societal maturity, represented by the generalised knowledge or information about the technology [10]. These are the main requests for a voluntary, safe, secure and effective use of an automated vehicle, as a driver or passenger. Any unfinished maturity means that the system is not ready for a full use, which can lead to increased risks and related disastrous events. Besides the risk of crashing, the main consequence of a lack of risk awareness is a low or lack of trust on the system, which is a main factor towards avoidance or even rejection of the technology. Thus, trust has a major importance for the development of an intention to use and to get the necessary knowledge and experience about the system towards its understanding and safe use.

Hoffman et al. [11] compare trust in machines with interpersonal trust saying that "*once lost, trust in automation, like interpersonal trust, can be hard to recover*". Concerning the modes of trust in intelligent systems, the authors say that trust in automation is limited to how far the user's skills based on his/her past experience can allow him/her to predict the system behaviour in a new situation. This means that the user learns using the technology and acquiring some knowledge that ease to understand the system behaviour. This process can be successful if the user behaves with safety in mind, but it will be disastrous if the driver starts testing the technology limits, pushing the vehicle limits until risky situations and high-risk levels. This is a result of overreliance and a kind of misuse [8].

Färber et al. [12] introduce communication issues between automated vehicles and human drivers at different levels. Besides the permanent communication between the driver and the system, there are other communication needs introduced by the traffic and road users' diversity. Thus, the resulting interactions introduce communication needs,

some of them new, as a result of the variability of road users and their vehicles. From explicit to implicit communication, there is must to put on the equation and new research needs.

Coming back to the truck platooning technology, the communication needs are an important topic as new and requiring new interfaces to be designed and developed. Thus, there are communication needs between the leading driver and the follower(s), together with communication between the leading driver and the system (both ways), communication needs between the drivers and the company, and communication needs from the truck platooning to the other road users and road environment. This requires deep research with experiments in a truck simulator and lately, in real traffic conditions.

With the introduction of the truck platooning technology, both operational conditions impose different tasks, and thus, different drivers' activity. This means that the main task of the leader is driving a level 2 or 3 automated truck, which means that his/her activity is represented by the corresponding regulation loop to perform the driving task, being ready to take over the vehicle control when requested by the system. The follower(s) don't perform a driving task, but instead, their activity is mainly centred on monitoring the information provided by both the system and the leader, following instructions. As it is quite known, this is a role that humans are poor in performing for long durations. With increasing trust on the system, it is possible that leaders will start performing secondary tasks [3] having gained a sufficient level of trust in their performance [9]. This overreliance and the change of task priorities reflect major safety concerns in the context of truck platooning (Popken et al. 2008) increasing the risk of accidents as a result from a cognitive underload and reduced situation awareness, giving rise to drowsiness and consequently, a decrease of the operator's ability to promptly react [3].

Merat et al. [13] suggest that driving a vehicle with some levels of automation imposes to the driver one of the following conditions: (1) being *In-the-loop* meaning that the driver is controlling the vehicle and monitoring the driving situation; (2) being *On-the-loop* meaning that the driver is not in a direct control of the vehicle, but he/she is still monitoring the driving situation; (3) being *Out-of-the-loop* means that the driver is not controlling the vehicle and he/she is not monitoring the driving situation. According to Endsley [14], the *Out-of-the-loop* condition leads to a loss of situation awareness, together with a lack of promptness for a takeover request, which impairs the driver for any urgent action. That's why it is not enough to measure reaction times in such situations, but instead, it is important to measure the quality of the immediate performance following a takeover request in order to assess the level of the driver's promptness to change his/her functional state.

The lack of knowledge and understanding of the vehicle technology, how it works, its level of automation and related limits, gives rise to an overreliance on the system, underlying further risky behaviour, such as unintended use, misuse, or even abuse [8]. Thus, user's acceptance and trust, avoiding risky behaviour resulting from overreliance or lack of trust, will come with appropriate education and training towards a required level of knowledge about the system functioning. However, previously to this, the design and development of any system for human use requires that human characteristics, abilities, skills and the previewed context of use will be taken into consideration in order to ensure an effective, efficient and safe use of the system. Designing with the human in mind is

necessary for the success of a new system for human use regardless the targeted context of use, either professional or utilitarian.

4 The Needs for Human System Integration

So far, the mission of designing and developing systems for humans' use has required a human-centred design (HCD) approach, integrating technology, organization and people as a model representing any sociotechnical system from the very beginning of the design process and along the life cycle of the system. HCD addresses the main principles and practice for the design and development of any system to meet human needs. Thus, HCD promotes a proactive approach in opposition to the corrective traditional Human Factors and Ergonomics (HFE) approach, even when involving iterative testing with humans. Targeting effective, efficient and sustainable systems, HCD anticipates, identifies, and prevents potential adverse effects related to human health, safety and performance by means of using modelling and human-in-the-loop simulation [15].

With the technological development, the automation era and the increasing complexity and emergency of systems require a well-developed integration plan to deal with the challenges arising from managing multiple sub-systems and/or interacting with their automated or autonomous sub-systems. According to Boy et al. [15] and Boy [10], human capabilities, skills and needs must be considered early in the design and development process and must be continuously considered throughout the development lifecycle. Thus, the integration of human needs within the system design is formalized through a Human-System Integration (HIS) program, which can reduce costs and increase efficiency, usability and products quality. This is a multidisciplinary field of research involving several user-related areas, such as Human Factors and Ergonomics, Systems Safety, Health Hazards, Human Resources, Training and Habitability [17].

HSI is a natural evolution of HCD and Systems Engineering (SE) using the human in-the-loop in the early phases of design [10, 15], having into consideration their capabilities, skills and needs, to develop their task(s), helping the organizations in reducing lifecycle costs and increasing the efficiency, usability and quality of products [17]. HSI should be seen as a holistic approach, while HCD has factors such usability, usefulness, safety, comfort, efficiency, and software reliability [10, 15].

Fitts et al. [16] mention three different types of risks possible to happen if the integration of Human Factors (HF) and HSI are not contemplated: (1) risk of error due to inadequate information; (2) risk associated with poor task design and (3) risk of reduced safety and efficiency due to poor Human Factors Design (HFD). For the first one, an insufficient integration of HF in the early phases of the project, can result in poorly designed interfaces due to inadequate testing, or inappropriate methodology for testing. The second risk is due to a lack of HSI leading to an insufficient or poorly conducted activity analysis that may result on a poor task design. The third risk is reducing the safety and efficiency as a result of a poor HCD on different stages of the project, which makes impossible to identify gaps and shortcomings processes and practices.

Being truck platooning an innovative system still under continuous technological development, the above-referred aspects should be taken into account. Considering that this system introduces two different and complementary tasks to be performed

by the driver and the follower(s), a deep analysis of the actual activity developed by each one during operation will be conducted using simulation and immersive technology. Such experimental conditions will create *In-, On- and Out-of-the-Loop* conditions for the collection of relevant data towards introducing human system integration in the system design and operation for the long haul of its entire lifecycle [13, 14]. Furthermore, new communication needs arise in a truck platooning system, such as: communication between the drivers on the platoon, between each one of them and the automated system, between the leading driver and the company, when necessary, and when and how to inform other road users about the platooning condition. The activity analysis will give answers to some of these questions and, mainly, it will direct the human-system-integration process towards perfect, efficient and safe operations.

5 Final Remarks

Truck platooning systems are mostly referred as making road transport faster, cheaper, cleaner and safer while, at the same time, increase the road capacity. This has been partially proved in several studies, according to the main focus of each one. However, other studies focusing on testing the truck platooning system operating within the actual road transport system found some aspects less positive, particularly depending on the traffic density. It is the case of a study conducted by Calvert et al. [17] proposing a set of recommendations to overcome some found limitations of the system, particularly influenced by the traffic flow. This is an example of the enthusiasm around a new and innovative system before achieving its maturity. So, the idea is good, but is it enough mature to be put into practice without enough iterative testing and development? Is a human-system integration approach behind the system development?

As an innovative system evolving within a complex and dynamic system represented by the road transport system, we are talking about a system of systems, being each one composed of, at least, a structure and a function, which can be physical and/or cognitive. Such complexity can be intrinsic of the truck platooning system, but it is increased with the complexity and dynamics of the road transport system, leading to uncertainty and increasing risks. Furthermore, each system is composed of three interactive elements: Technology, with its usefulness and usability; Organization, with its structure and functioning; and People involved in the system operation, from operators to stakeholders [10]. The system maturity, having a major importance for the platooning system, involves the technological maturity, which is developed in parallel with the maturity of practice, and the societal maturity regarding the addressed system, which is dependent on the local cultural evolution [10].

Thus, there is much to test and learn about truck platooning systems. Aiming at contributing to the state of the art in this domain, TRAIN is trying to fill the noticed gaps carrying out driving simulations to assess the main risks associated to truck platooning under partial automation (level 2, SAE). With such purposes in mind, driving simulations will be conducted to assess the main risks associated with truck platooning under partial automation (level 2 defined by SAE International). Under these conditions, drivers must supervise the automated driving activity and properly respond to any request to intervene in different environmental conditions. Furthermore, the reduction of driving tasks to be

performed by follower drivers may affect their capabilities to respond to an unexpected event involving the leading vehicle or to replace the leading driver after a planned stop. Thus, the simulations will be designed to (i) evaluate the levels of understanding of the system and the levels of situation awareness of truck drivers in platoon, and (ii) test safe following distances, considering the balance between takeover performance, gains of fuel consumption, and the probability of car drivers to cut into the gap between platooning trucks. The collected data will be processed using advanced statistical and machine learning techniques to predict the evolution of drivers' alertness levels across time and to derive safe and efficient thresholds for takeover and following distances. Together with the previously collected qualitative data from professional truck drivers, the results from driving simulations will also allow to develop a drivers' acceptance and trust model of this new technology.

In the end, TRAIN will deliver design and operation guidelines and recommendations to the truck platooning industry, operators, stakeholders and road safety authorities, based on robust driver acceptance and behavioural models, which will reflect a comprehensive mapping of training needs and risk factors for a safe and acceptable deployment of truck platooning on public roads.

Acknowledgements. This work is financially supported by national funds through the FCT/MCTES (PIDDAC), under the project PTDC/ECI-TRA/4672/2020.

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Are You Anxious? It's All About Tolerance of Ambiguity - The Influence of Different Tolerance of Ambiguity on Second Language Learners

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Abstract. In second language learning, listening and comprehension are essential processes in knowledge extraction and information processing. Cultural differences will encounter many ambiguous situations, which will make the learners feel nervous and uneasy. At this time, the level of tolerance of ambiguity will affect the results of language understanding. Therefore, studying the tolerance of ambiguity in listening comprehension improves second language comprehension and a better understanding of culture under different social backgrounds. Our research focuses on tolerance of ambiguity on second language users' speech understanding and foreign language anxiety when using English in different situations. In this study, we interviewed 6 students with bilingual training experience, and used the tolerance of ambiguity scale to test 60 students with bilingual training experience, and came to the following conclusion: different tolerance of ambiguity in different scenarios affect the second Language learners have different influences; second language users with a high tolerance for ambiguity have better speech comprehension performance and less foreign language anxiety than second language users with a low tolerance for ambiguity; contrast situation and tolerance for ambiguity, Scenarios such as comparing the classroom environment, in the daily environment of high tolerance for ambiguity and a low tolerance for ambiguity second language users have better speech comprehension performance, and produce less foreign language anxiety. This research aims to find ways to improve the tolerance of ambiguity in different situations to improve the language comprehension performance of second language learners and reduce their foreign language anxiety.

Keywords: Tolerance for ambiguity · Hearing anxiety

1 Introduction

As an essential factor that affects learners' language learning and language communication in a second language environment, vague tolerance is the learner's cognition of the phenomenon that they cannot understand and feel vague in foreign language learning

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 523–531, 2022.
https://doi.org/10.1007/978-3-030-85540-6_66

and communication. And the degree of acceptance and how to deal with ambiguous situational behaviors [1]. When learning and communicating in a second language environment, learners often encounter ambiguous situations, such as meeting unfamiliar topics, unfamiliar words, complex contexts, etc. Second language learners who can accept this kind of ambiguity or situation think their level of tolerance for ambiguity is high, and vice versa [2]. Research has found that tolerance for second language learners' ambiguity situations tends to vary from various dimensions. Affect their efficiency in learning and using language, such as language comprehension ability, anxiety, vocabulary reasoning ability, etc. [3].

More relevant research now focuses on the impact of second language learners' tolerance for ambiguity in text reading on their second language learning. Whether they are learning and communicating in the second language, especially in listening comprehension, The same problem exists [4]. Previous studies have only focused on the impact of vague tolerance on second language learning in the teaching environment. In other scenarios, whether the impact of tolerance for ambiguity on dual language learners is also required Are we concerned? Therefore, in this study, we will improve and expand the research on the tolerance of vagueness based on previous investigations and convert the research on tolerance of ambiguity in text reading into research on tolerance of ambiguity in listening comprehension. The research scenarios of the last single classroom teaching scene have been expanded into a dual-scene study of teaching scenes and daily scenes [3]. It also explores everyday bilingual life scenes when foreign language learners use a second language to communicate. Whether it is also affected by the tolerance of ambiguity, we should also pay attention to whether the impact of tolerance of ambiguity in daily communication scenes on foreign language learners is different from its impact on them in the teaching environment, and whether the level of tolerance of ambiguity affects them To what extent does the listening comprehension process of second language learners affect the listening comprehension process, we will also focus on ways to improve the tolerance of vagueness in different situations, to help improve the language comprehension ability and vocabulary of second language learners in learning or using the second language. Reasoning ability and reduce their anxiety when learning or using a second language.

In this study, we mainly target students who have experience in second language training, and they also have experience in using a second language in daily situations. These students are divided into two parts; one part is six international students who have just studied in the United States; they are in a natural second language environment, whether they are classroom teaching scenes or daily scenes. They are faced with more vague tolerance problems. They have a more precise feeling about their fuzzy tolerance in different situations, so we choose to Interview them using the interview method and conduct a qualitative analysis of the interview results. Another part of the 30 students who have experience teaching English in China has a small amount of English com-

munication experience in daily life. We choose to Use questionnaire surveys to collect their feelings about self-ambiguity tolerance and quantitatively analyze the results of the questionnaire. The results will be compared and verified with the qualitative analysis results obtained from the interviews with six international students. Our research scenario design Determine the situation of students' vague tolerance when learning or using a second language in the teaching scene and in the daily location, use interviews and questionnaires to understand the feelings of second language learners and analyze the results qualitatively and quantitatively.

Our research hypothesis is: different ambiguity tolerance has other effects on second language learners in different scenarios; dual language users with high ambiguity tolerance have better speech comprehension ability than second language users with low ambiguity tolerance Stronger, it produces less foreign language anxiety; in different situations, compared with classroom teaching scenes, the second language learners in the daily environment have better speech comprehension ability, and produce less foreign language anxiety.

2 Method

Based on the previous literature findings, we first conducted interviews and data analysis for several modules based on the rooting theory and using a qualitative analysis research method.

Qualitative research is the approach used by researchers to define a problem or address a problem. The specific purpose is to delve into the particular characteristics or behaviors of the object of study and further explore their reasons. If quantitative research addresses the question of "what," qualitative research addresses the question of "why."

2.1 Interviewing

Interviewing Subjects. According to the purpose of this study, six interviewees in the age range of 18 to 25 years old with bilingual learning experience were selected. Three of them were male and three were female.

Interview Outline. This study adopted semi-structured interviews, which are characterized by the ability to tailor and adjust the interview content according to the actual interview situation during the interview. Before the interview, the author developed an interview outline based on the interview requirements to guide the discussion, as shown in Table 2. The interview outline was divided into three parts: first, to understand the basic information of the interviewees and to guide them into the interview situation; second, to interview them about their previous use of their mother tongue and second language in the second language learning classroom; second, to find out whether they had any anxiety in the classroom situation due to blurred hearing; and finally, to compare whether their use of the second language in daily life was the same as that in the classroom situation (Table 1).

Table 1. Interview outline

Category	Questions	Purpose
Basic information of the interviewees	1. Age, occupation 2. English level	Obtain basic information about the subject and guide the subject into the interview situation
Contextualizing second language use in the classroom	1. Do you use your native language to communicate with your classmates in second language classes? 2. When you don't understand what the teacher is saying, do you ask the person to repeat the explanation until you understand? 3. How do you feel when you don't understand a sentence or a word in the classroom? How would you solve it? 4. When you are in the classroom, do you skip over words and sentences you don't understand, or do you continue to try to understand them? 5. How do you think cultural differences affect listening comprehension? 6. In the classroom, what is the approximate percentage of whole sentences you translate from second language content into your native language?	Whether there are problems in the classroom situation due to blurred hearing If and when you experience anxiety due to blurred hearing Does tolerance of ambiguity and listening style affect listening anxiety
Second language use in everyday contexts	1. In what contexts do you use second language in your daily life? 2. How do you feel when you don't understand the second language in your daily life? How would you solve the problem?	Comparing listening blur in everyday contexts with listening blur in the classroom

Interview Process and Organization. The interview was conducted offline, and the subjects signed an informed consent form before the discussion began and were helped to understand better the background, purpose, and process of this interview. During the

interview, a semi-structured interview was conducted according to the interview outline, and the order or content of the interview questions was adjusted with the subjects' responses.

After the interviews, the author imported the six interview raw materials into the NVivo11 software and used a systematic procedure to continuously summarize and analyze the interview raw materials around the purpose of the interviews, which was divided into three levels of coding: first, the first level of coding is the data interpretation process of identifying data and phenomena and forming concepts, optimizing, analyzing and selecting the formed ideas, and collecting pictures of the same category of images. In this study, 523 nodes were extracted, and the corresponding concepts were analyzed and refined to form concept clusters.

Secondly, secondary coding aims to simplify and distinguish the main categories based on the classification. The relevant conceptual categories are divided together in Nvivo to form the main types. After selecting the main categories, they are compared with the original manuscript one by one to check the authenticity and reliability of the extracted contents.

Finally, tertiary coding aggregates all conceptual categories through integration and condensation and finally refining the core categories. The specific method is to construct the main types to meaningful storylines before inductive analysis and then find the core categories.

Table 2. Interview coding results

Core categories	Spindle coding	Open coding
Ambiguity tolerance	Hearing anxiety level	I don't feel anxious because I don't understand a certain sentence At the beginning, there is a timid mentality of not understanding, later will be relieved I feel anxious when I don't understand a big conversation in second language during my study

(*continued*)

Table 2. (*continued*)

Core categories	Spindle coding	Open coding
	Listening strategies	I capture key words to help me understand when I don't understand The second language will first be translated into the native language in the brain I will remember more words to increase vocabulary in general I will ask teachers and classmates when I don't understand If you can't understand individual words, it doesn't affect your understanding of the whole sentence
Situational differences	Hearing blurred feelings in the classroom	It is frustrating to not understand many words in class It can be embarrassing to ask a classmate or teacher if you don't understand When I don't understand, I write down the location of the point and look up the translation after class
	How I feel when I don't understand the second language in my daily life	The use of second language in daily life is a little more casual and does not require much grammatical correctness It would feel awkward not knowing how to express it in second language
Cultural influences	Native language environment	In your familiar environment, you won't feel anxious no matter what language you speak I feel nervous talking to foreigners
	Second language environment	A purely second language environment can be more conducive to learning It takes a long time to adapt in a bilingual environment

Discussion of Interview Results. Through in-depth interview studies, we can know the second language learners' second language use in different contexts, and find out their problems and application strategies in the process of second language use, and condense the factors affecting the feeling of second language use into three latitudes based on the rooting theory, which are "ambiguity tolerance", "contextual difference" and "cultural influence". "and "cultural influence". Based on these three latitudes, a questionnaire will be developed to conduct a quantitative questionnaire study.

2.2 Questionnaire Survey

Data Source. We conducted a questionnaire survey on a sample of people aged 20–26 years old in Beijing who had experience in bilingual courses. Finally, 62 questionnaires were returned, of which 60 were valid, with an effective rate of 96.77%. The survey used a fuzzy tolerance scale with 20 questions.

Core Variables. In this scale, "I feel frustrated when I try to understand every word of a sentence and cannot." "I feel uncomfortable when I understand every word in a sentence, but I just can't understand the meaning of the sentence." "When I listen to a conversation, I feel annoyed if I can't write down the keywords." Etc. 9, 10, 11, 12, 13, 14, 15, 17 total eight questions measure the fuzzy indicator tolerance.

In this scale, "When I listen to English material, I feel impatient if I do not fully understand its meaning." "I feel annoyed when I don't understand the teacher's English speech." The four questions of 1, 2, 6, 8, etc., measure the indicator of foreign language anxiety.

In this scale, "If I don't understand an English word several times, I get anxious, which affects the following listening materials." "When I listen to English material, it is difficult for me to concentrate on the following material because it is difficult for me to desert." A total of 3 questions, such as 3, 18, and 19, measure the ability to comprehend verbal language.

Ambiguity Tolerance and Foreign Language Anxiety. We conducted a Pearson correlation analysis on the two core variables of ambiguity tolerance and foreign language anxiety, and the results are shown in Table 3. The correlation coefficient between foreign language anxiety and fuzzy tolerance was −0.654. It showed a significance at the 0.05 level, thus indicating a significant negative correlation between fuzzy patience and foreign language anxiety, i.e., the higher the fuzzy tolerance, the lower the foreign language anxiety.

Table 3. Results of Pearson correlation analysis of ambiguity tolerance and foreign language anxiety

		Foreign language anxiety
Ambiguity tolerance	Correlation coefficient	−0.654*
	p-value	0.021

Ambiguity Tolerance and Verbal Comprehension. We conducted a Pearson correlation analysis on the two core variables of ambiguity tolerance and verbal comprehension, and the results are shown in Table 4. The correlation coefficient between oral awareness and fuzzy tolerance was 0.625 and showed a 0.05 level of significance, thus indicating that there is a significant positive correlation between fuzzy tolerance and verbal comprehension, i.e., people with higher fuzzy tolerance also have higher oral understanding.

Table 4. Results of Pearson correlation analysis of ambiguity tolerance and verbal comprehension

		Verbal comprehension
Ambiguity tolerance	Correlation coefficient	0.625*
	p-value	0.030

3 Conclusion

In everyday settings, second-language speakers with high ambiguity tolerance had better speech comprehension performance and produced less foreign language anxiety than those with low ambiguity tolerance.

Second-language speakers with high ambiguity tolerance had better speech comprehension and less foreign language anxiety than second language speakers with low ambiguity tolerance.

4 Discussion

Through the research results, we can see that the level of tolerance for ambiguity affects second language learners' learning efficiency and learning effect in different scenarios. The results of this research are in line with our standard assumptions, and the results are more significant. This research will continue to follow. Pay attention to some issues. Question 1. Why do second language learners with the same level of ambiguity tolerance show different second language learners performances in different scenarios? What are the other factors that affect them in different systems? Do these factors have a positive effect on improving the tolerance of ambiguity? The second question is whether it is possible to develop a method for second language learners to improve the vague tolerance based on the factors that affect the tolerance for ambiguity in different scenarios. Second language learners are more ambiguous in the second language. The increased tolerance of phenomena allows them to habitually process and understand the meaning of sentences as a whole. At the same time, the patience of vagueness is also inseparable from the learning style of second language learners. Our follow-up research will also learn from the second language. To understand the relationship between different learning styles and tolerance of ambiguity and how the two influence each other.

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The "Pandemic Effect" on e-Commerce

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Abstract. The COVID-19 pandemic has led us to new social behavior. To contain the virus, governments have imposed social distancing and confinement. The fear of contamination and the inability to go out to buy essential and non-essential goods intensified the perceived threats associated with offline channels, as well as the perceived benefits and relative attractiveness of digital ones. This dynamic has shifted the market towards online platforms. This paper intended to identify new behavior patterns in online shopping as we face an unprecedented scenario. We conducted exploratory interviews with 18 people and constructed an online questionnaire that had 327 respondents. Our findings reinforce the relationship between a flawless consumer journey (from pre- to post-sales) and a positive shopping experience.

Keywords: E-commerce · Human-centered design · UX · Covid-19

1 Introduction

The COVID-19 pandemic has exerted an unprecedented impact on almost every aspect of society. Governments have taken various measures to combat the spread of the virus, including shutting down shops that are considered non-essential. In nations worldwide, some sort of confinement, as well as social distancing, were imposed by local authorities. In March 2020, at least 37% of the population were in some kind of lockdown [1].

Such restrictions have led consumers to adopt new behaviors or to reinforce established ones, to the increase of new e-shoppers, and the adoption of new shopping habits by existing e-shoppers. Our primary objective was to identify how the perceived risks of buying offline and the perceived benefits of buying online have stimulated new behavioral patterns and helped to overcome switching costs as we face an unprecedented event.

2 Theoretical Background and Hypotheses Development

There are four significant settings that govern or disrupt consumer habits [2]: social, technological, rules, and regulations, and the ad hoc natural disasters including the Covid-19 pandemic [2].

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 532–540, 2022.
https://doi.org/10.1007/978-3-030-85540-6_67

In Brazil, following the announcement of the first case of COVID-19 there was an above-average increase of new e-shoppers [3]. In April 2020, e-commerce sales almost duplicated, representing an 81.6% increase [4].

In Portugal, 54% of consumers have declared they are shopping more online than ever [5]. At the beginning of 2020, there was a sharp increase in the registration of.pt domains, which may be related to small and medium businesses' response to the crisis as they transition to digital channels [6].

The novel coronavirus pandemic almost eliminated brick-and-mortar stores; only essential services were allowed to open and were subjected to new norms. Supermarkets and drugstores have operated under several restrictions, including reduced opening hours and capacity [7, 8]. This scenario, combined with the fear of contamination by COVID-19, redirected millions of consumers to online channels.

2.1 Perceived Threat

Consumers have engaged in online shopping as a form of self-protective behavior, a reaction to the perceived threat [9, 10]. Whenever individuals perceive risk, they develop self-protective behavior not usually observed in their buying decision-making. However, during disease outbreaks, such as the COVID-19, this self-protective behavior becomes significantly pronounced [11].

This self-protective behavior has induced consumers to make a digital transformation [12], stimulating the shift to digital and overcoming some barriers that served as a deterrent to buying online. The ongoing uncertainty evoked by the pandemic may lead to transformative consumption patterns in the long term [13].

Perceived threat can be a key element in understanding the practice of various preventive health behaviors [11]. It is an individual's cognitive assessment of the likelihood danger will affect them and how bad it will be if it does. Perceptions of threat, accurate or not, are key to predicting adaptive health responses that help protect oneself from danger [14]. Consequently, e-commerce, and any type of distance buying, has been massively adopted, thus we hypothesize that:

H1: Perceived threat of getting COVID-19 positively influences the adoption of online purchases.

2.2 Relative Attractiveness

The amount/quality of offers makes a channel more or less attractive, this dynamics is described as 'relative attractiveness' [15]. The perceived benefits associated with a purchase may have an effect on our health-related behaviors as well as the perceived risks associated to an action [11, 16]. The perceived benefits of online channels increased as limitations were imposed by local authorities worldwide. Consumers faced the impossibility and risks to leave home and the shutdown of non-essential commercial establishments [17, 18]. Perceived benefits refer to an individual's assessment of the value or efficacy of engaging in a protective behavior to decrease risk [19].

People tend to engage in a specific activity if they assume it will minimize their exposure to a health problem (perceived risk) regardless of the efficacy of that action

[20]. The concept of perceived risk [10] is defined in terms of the uncertainties and consequences associated to consumers' actions. We posit that:

H2: The perceived risks related to the COVID-19 increased the relative perceived attractiveness of online channels.
H3: Perceived benefits of online buying positively influence customer's purchase decision towards online channels.

2.3 Search Costs

Consumers often need important information about products and services when making a buying decision. Search costs are the costs incurred by a consumer in identifying a product/service and price, regardless of if the consumer then buys the product/service [21].

Consumers invest resources to locate appropriate sellers [22], this includes monetary costs to acquire information, opportunity costs of time in foregone activities, these are considered external search costs [23]. Such costs are determined or influenced by factors that are beyond consumers' control. According to Smith et al. [23], they are exogenous and depend on situational influences as the ones imposed by the pandemic.

The pandemic has changed the economic environment for sellers and buyers. In normal conditions, most consumers have more control over the search costs, they can decide whether to incur these costs, to buy online or offline. When one of these channels almost ceases to exist, they have no choice but to subject themselves to the conditions imposed by this new reality.

H4: Increased offline channel search costs lead to adopting new shopping habits.

3 Methodology

Our study focused on Brazil and Portugal. Both countries have been severely impacted by the coronavirus pandemic [24]. To explore behavioral patterns during the pandemic, we carried out exploratory interviews followed by an online questionnaire.

To recruit volunteers for the exploratory interviews, we posted a message on Facebook and Instagram with the question: 'How has been your experience with e-commerce during the quarantine? Can you tell me by direct message?" In total, 18 interviews took place between 12th April and 8th May 2020.

The online questionnaire was divided into the following sections: demographics; new shopping habits; and online experience. The questionnaire was disseminated through social media channels and by email, it was available from 7th May–3rd June 2020.

4 Results

4.1 Exploratory Interviews

The interviews were transcribed and coded using MAXQDA software and the Content Analysis method. We created 9 categories of codes (Experience, Delivery, What?,

Why? Where? and How?, Exchanges/Returns, Price, Presentation and Other) and sub-categories for 6 of those categories.

"Experience" was the most frequently mentioned code, then "Delivery", "What they bought?", and "Where and How", with 27.8%, 23.7%, 18.7%, and 17.7% of mentions, respectively. These 4 categories represented more than 50% of mentions and are discussed in the following paragraphs.

Overall, the online experience has been positive (45% of mentions). Interviewees mentioned the importance of communication and transparency throughout the buying process and demonstrated feeling safer when receiving information about the process status. Statements regarding negative experiences were mostly related to out-of-stock products and negative delivery experiences.

In the "Delivery" group, 30% of mentions referred to successful instances, 42% stated negative experiences such as long delivery times, confusing processes, and lack of transparency.

Interviewees bought more non-essential (58%). We categorized essential and non-essential according to the Brazilian Society of Retail and Consumption [25], which includes food, medication, pet supplies, and construction and building materials. Most of the interviewees declared they had purchased on the companies' websites (44%) or app (26%).

4.2 Online Questionnaire

There were 327 respondents, our sample was calculated considering a 5% error margin and 95% confidence level. 75% Brazilians, 20% Portuguese, and 5% were from other countries. The ages ranged from 19 to 82 years ($M = 45.43$ and $SD = 16.9$).

The respondents were divided into 2 groups: "e-shoppers" (ES) and "new e-shoppers" (NES), those who had bought online for the first time during the quarantine. From the questions related to their shopping habits, we calculated nine new variables: UX Search; UX Delivery; UX After-sales; UX Search Positive Experience; UX Delivery Positive Experience; UX After-sales Positive Experience; UX Search Negative Experience; UX Delivery Negative Experience; and UX After-sales Negative experience.

Cronbach's alpha was used to measure the questionnaire's internal consistency in the cases where there was a grouping using the average of the respondents' positions. High alpha values (>0.8) show an almost perfect internal consistency while values below <0.21 show reduced consistency. In our work, and considering the reported alpha values, we found almost perfect (>0.8), substantial (>0.61), and moderate (>0.41) values, therefore validating our new variables.

We then carried out several binary logistic regressions to check whether some sociographic characteristics and the characteristics of online purchases that respondents made would be predictors of potential changes in purchasing habits following the spread of the SARS CoV 2 virus. Thus, identifying the possible influence of some of the parameters under study in the potential establishment of new behavioral patterns.

In the case of NES, the question "Do you intend to continue shopping online?" was considered the dependent variable (DV). For the ES, we considered the question "Did you start to buy more frequently online during quarantine?" as the DV. The answers to

these questions can best characterize potential changes in behavioral patterns in this subgroup. The following categories were significant predictors of future behavioral patterns for both subgroups (NES and ES) showed statistical significance: What they buy online; First-time purchased items during quarantine; Platforms used to buy online; Relationship/Association between variables | Satisfaction with experience; Payment method; UX – Positive experience; Online experience.

The NES consisted of 20% men and 80% women, aged 21–72 years, 74% lived in Brazil, 20% in Portugal, and 6% in other countries. They represented 4.5% of the total number of respondents.

Table 1 lists the relationship/association between the respondents' selections and positions regarding parameters under analysis versus online shopping experience, verifying their willingness to adopt digital channels. Table 2 shows the items with statistical significance and how most of the respondents positioned themselves in the satisfaction scale. These results partially support H1.

Table 1. Relationship/association between the respondents' selections and positions regarding parameters under analysis vs. online shopping experience (NES).

	Test (Chi-square)	Ass. degree (Cramer's V^2)
Companies' apps vs. OSE*	$X^2 = 7{,}045$; $p < 0{,}05$	68,5
Debit vs. OSE*	$X^2 = 6{,}071$; $p < 0{,}05$	4,8
Buy online vs. OSE*	$X^2 = 6{,}964$; $p < 0{,}05$	3,1
Positive search vs. OSE*	$X^2 = 16{,}181$; $p < 0{,}05$	4,0

*OSE – Online shopping experience

Table 2. The items with statistical significance and how most of the respondents positioned themselves in the satisfaction scale.

Item	Category	Most frequent position
Platforms used to buy online during quarantine	Companies' app	3
Payment method	Debit	4
Intention to continue buying online	Do not intend	5
	Do intend	4
UX	I found all the items I needed	5

The ES consisted of 35% men, 65% women, aged 19–82 years. Most of the respondents lived in Brazil, 74%, 21% in Portugal, and 5% in other countries. The relationship/association between their respondents' selections and positions regarding parameters under analysis and matters alluding to the online shopping experience are described as follows.

The relationship between the intention to shop more online and satisfaction proved to be statistically significant. During the quarantine, 70% of the respondents started buying more frequently, and 30% kept the same frequency. The respondents who intend to increase their shopping frequency positioned themselves higher in the satisfaction scale (4 – satisfied). These results support H2 and H3 for the ES subgroup (partially for the NES subgroup).

The tested associations with positive and negative user experiences, and per item under evaluation showed statistically significant relationships with the respondents' satisfaction level (Table 3). The tests revealed that shopping satisfaction is related to a positive experience in any of the UX stages. These results support H4 for positive experiences.

A negative UX is statistically related to the level of satisfaction regarding search, delivery, and after-sales. Respondents who experienced a negative search and shipping/delivery process registered a more significant number in position 1 (Very dissatisfied).

Table 3. Relationship/association between the respondents' selections and positions regarding parameters under analysis vs. online shopping experience (ES).

	Test (Chi-square)	Ass. degree (Cramer's V^2)
Shopping frequency		
Will buy more often vs. OSE*	$X^2 = 11{,}012$; $p < 0{,}05$	2,6
Positive UX		
Positive search vs. OSE*	$X^2 = 35{,}458$; $p < 0{,}05$	17,2
Positive delivery vs. OSE*	$X^2 = 85{,}874$; $p < 0{,}001$	26,8
Positive after-sales vs. OSE*	$X^2 = 72{,}948$; $p < 0{,}001$	24,7
Negative UX		
Negative search vs. OSE*	$X2 = 32{,}669$; $p < 0{,}05$	16,5
Negative delivery vs. OSE*	$X2 = 71{,}377$; $p < 0{,}001$	24,4
Negative after-sales vs. OSE*	$X2 = 69{,}225$; $p < 0{,}001$	24,1

*OSE – Online shopping experience

5 Discussion

For the NES and ES, the best shopping experiences resulted from a smooth overall buying process. Despite the positive experiences, a part of the NES group will probably return to their pre-pandemic shopping habits. As for the ES subgroup, the individuals who experienced positive buying processes intend to buy more often henceforth. Positive search, delivery, and after-sales processes were determinant contributors to a positive UX. A flawless consumer journey is essential for satisfaction, from pre- to post-sales. The pandemic has highlighted the significance of logistics to UX. Delivery processes

have to be transparent and precise; companies must inform delivery times and guide the user throughout the process.

To make these new behaviors last, companies should invest equally in all parts of the journey, humans should be at the center of every stage. Human-centered design (HCD) approaches not only consider human needs, skills, and limitations but also consider the context and the sociocultural meaning [26]. In times of uncertainty, the company's ability to be empathetic intimate, and trusted is going to matter and can lead to customer loyalty and satisfaction [27]. HCD has contributed substantially to what [28] refer to as the 'second wave of corporate branding' [29].

In addition to the quantitative results, we point out some qualitative contributions. *WhatsApp* was frequently mentioned as a tool to contact businesses, these transactions are called *Conversational Commerce*. Messaging apps bring point-of-sales to the consumer, delivering convenience and decision support [30]. Buying via *WhatsApp* has been increasingly adopted because it resembles the in-store experience.

6 Conclusions

The pandemic paved the way to a new market scenario, anticipating behaviors, and the adoption of technology. We will hereby call it the "pandemic effect". The "pandemic effect" has influenced consumers and sellers and served as a catalyst for the anticipated adoption of certain technologies. The results from this study provide insights to improve e-commerce processes that might go unnoticed in a usual scenario. Digital platforms need to be transparent, give information, manage inventory efficiently, and ensure seamless logistics. The restrictions imposed by the pandemic are an opportunity to understand what works and needs to be improved. These changes can transform UX entirely, not only now but also in the future. The pandemic brings a new perspective on how companies should see their consumers. More human approaches must be adopted, consumers should not only be seen as buyers, but as partners that companies cannot exist without. Analyzing from the human perspective and not only from the business perspective is the contribution that Design can give to businesses; enhancing the UX will result in happier consumers and increase consumer loyalty. Transparency and more empathetic approaches should be embraced to stimulate more satisfying purchases. Furthermore, improving the efficiency of supply chains and logistics contributes to a more sustainable business which is beneficial for companies' reputations as consumers grow more conscious.

Acknowledgments. This work was supported by Fundação para a Ciência e Tecnologia (2020.04596.BD) and CIAUD.

The data that support the findings of this study are available from the corresponding author, [C.B.], upon reasonable request.

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Emerging Technologies and Applications



Digital Transformation Affecting Human Resource Activities: A Mixed-Methods Approach

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Abstract. Digital transformation currently affects all parts of society. We believe it is important to investigate what impact a company's digital transformation has on its HRM and its activities. Thus, we apply a mixed-methods approach to observe this technology-induced shift. We analyze the annual reports of German DAX companies from the last ten years using a text mining method and a qualitative content analysis. After discussing the results in interviews with HR managers, we present our main findings: As suggested by our literature review, we cannot establish a uniform correlation between digitization and HR activities as the technology usage varies greatly between HR activities. Strong external influences affect the developments at personnel, organizational and market levels. Further research—also in international settings—is necessary.

Keywords: Digital transformation · eHRM · Human resources · Mixed methods · Qualitative content analysis · Text mining

1 Introduction

"Digital transformation is the transformation of business processes, operations and structures in order to exploit the benefits of new technology." [1]. Thus, digital transformation does not only have far-reaching effects on almost all aspects of our society, but also has a major influence on the role, processes, and practices of human resource management (HRM) [2–4]. On the one hand, administrative and repetitive processes such as payroll accounting or maintenance of master data are becoming automated or standardized through digital technologies [5, 6]. On the other hand, the general working environment and, thus, the demands on HRM are also changing. The digital transformation is behind the change in the skills requirements of the staff, and the flexibilization of work models [7–10]. Figure 1 provides an overview of the different mechanisms according to literature. So far, little attention has been paid to a holistic analysis of HR activities in relation to all levels of impact of the digital transformation—particularly one that includes a longitudinal dimension [11–14]. In the present paper, we thus seek to explore the following research question:

How does digital transformation affect HR activities?

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 543–549, 2022.
https://doi.org/10.1007/978-3-030-85540-6_68

To achieve this goal, we apply a novel mixed methods approach to analyze annual reports using text mining, a qualitative content analysis, and interviews.

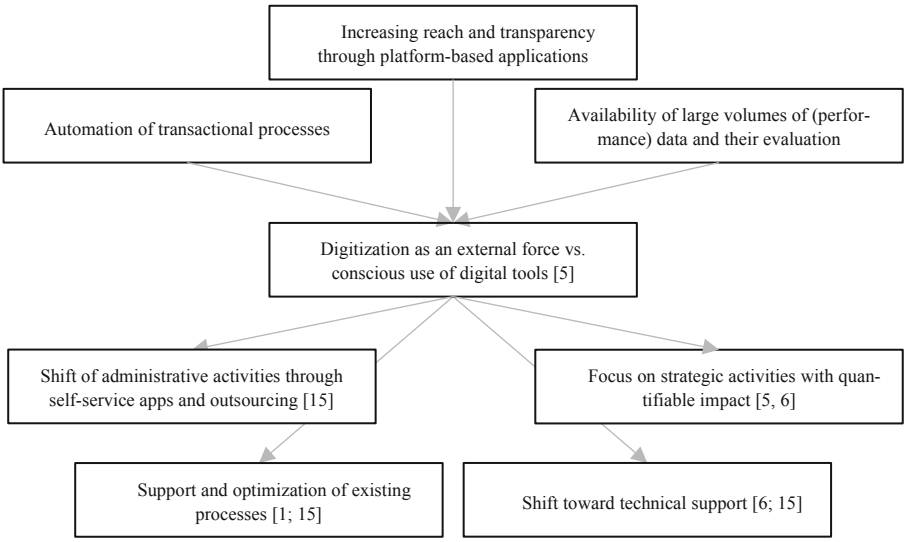


Fig. 1. Evidence to date on the impact of technology on HRM

2 Digital Transformation of HRM

Previous empirical results reflect different findings regarding digital change and the effects it has on HRM, as depicted in the bottom half of Fig. 1 [1, 4, 6, 14, 15]. To achieve a more detailed understanding of the mechanisms, we investigate the influence of digital transformation and its technologies on the eight different HR activities we derived from the literature: organizational design, staffing, human resources development, performance management, remuneration, employee relations, health management, and policies [16–18].

New technologies affect all parts of a company, which is why a constant adaptation of organizational structures and processes accompanied by HRM is necessary—even more so during the digital transformation [2, 14]. Thus, HR is increasingly confronted with the need to establish common values and norms as well as technology acceptance.

HR analytics provides an opportunity to use a large amount of data on demographics, employee turnover, job requirements, or performance indicators and to make forecasts [3, 14, 19]. The analysis of such large amounts of data supports HR managers in making sophisticated assumptions about the future demand for employees and their necessary skills as well as about careers and succession planning. Staffing thus gains further importance during the digital transformation due to a shift in skills [7, 8]. Due to the changing demands, HR needs to upskill the affected employees. Thus, obsolete functions can be replaced, and retrained staff can be kept in the company [10, 20]. Observing and

adjusting the development processes is also affected by digital technologies. They support performance management both in measuring appraisal content and structuring the feedback process [21, 22].

The largest areas of application for digital technologies in remuneration are the automation of salary processing, the adjustment of salary structures, and the administration of compensation and additional performance incentives [23]. Particularly in a country like Germany, where co-determination rights and guidelines are regulated in a more extensive and employee-friendly manner than in any other European country, employee participation plays a decisive role [24, 25]. Digital communication tools and social media platforms improve internal communication between the parties [26–28].

By promoting the well-being of employees at all levels, HR can help to develop a committed and satisfied workforce that is more performance-oriented and has lower absenteeism and turnover rates [29]. HR therefore has the responsibility to increase awareness about technology use and well-being. In terms of physical health, sensor systems and wearables offer the opportunity to record, identify, and evaluate safety-related incidents and physical health data [20, 30]. The consequences of the digital transformation described above require constant adjustments to personnel policies and procedures. Particularly in the area of employment models and occupational health and safety, new challenges arise for HR to implement complementary guidelines in order to ensure ethically correct treatment of those employed [31].

3 Empirical Data from 27 DAX Corporations

While the literature review outlined above reveals extensive research on individual HR processes and activities, it lacks holistic empirical data on the digital transformation over time as well as the current status of digitalization in practice. To address this issue, we opted for a novel approach: analyzing annual reports. Compared to surveys, the use of these documents significantly reduces the response bias. For our analysis, we considered HR-relevant sections from 27 German DAX companies over a period of 10 years (2009–2018). Since the most important industries are represented, the generalizability of the results improves. Having extracted all the text passages in the reports that refer to HR, the research basis thus comprises text sections from a total of 444 documents. We analyzed these documents using the statistical software RStudio and applying the tidy text mining method, including its text mining packages and OCR Tesseract [32–34]. We assigned the resulting bigrams to the core activities derived from literature, basing our approach on a qualitative content analysis [35]. The final dataset consists of 5,894 bigrams in eight categories and 39 subcategories. We discussed the results with four HR managers from the observed corporations to gain a better understanding of company-specific technologies, strategies, and decisions. Figure 2 provides an overview of the analysis.

The results show a clear starting point for digitalization activities for most companies. In 22 cases, a significant increase in terms associated with digitalization is visible. The years in question are those between 2012 and 2017, with the focus on 2015.

A linear regression analysis comparing each HR activity with the terms on digitalization shows correlations with a varying degree of significance. The direction of the influence also differs. Figure 3 provides the details.

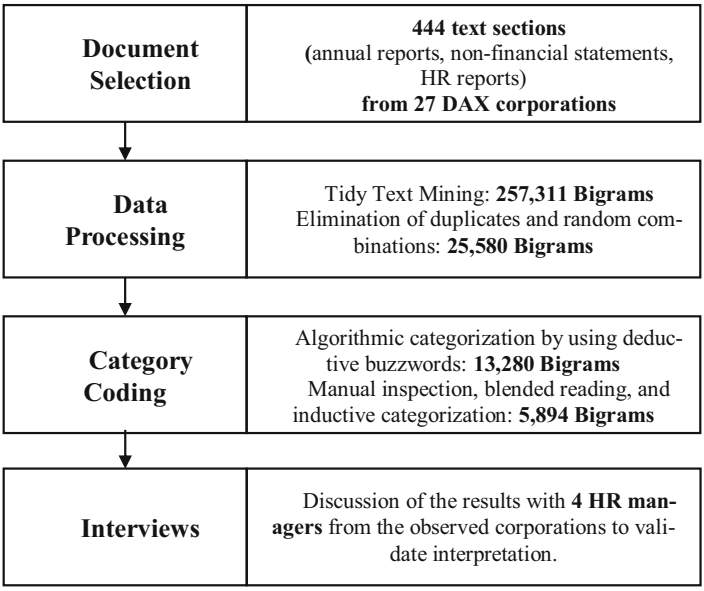


Fig. 2. Process of data collection and analysis

ANOVA with digit*	b	σ_n	R^2
Organizational Design	6.2445	3.0559	.34
Staffing	-4.778	2.8511	.26
HR Development	0.3985	2.5361	.00
Performance Management	-0.3106	2.9479	.03
Remuneration	-6.5652	1.5648	.69
Employee Relations	1.8037	1.5048	.15
Health Management	6.0200	3.1303	.32
Policies	3.9850	2.9479	.43

Fig. 3. Linear regression on terms related to HR activities and digitalization

Furthermore, a more detailed analysis of the data reveals that some outliers are not explained by digitalization efforts. Close reading of the annual reports and interviewing the HR managers help us to understand why. The companies react to their individual market environment with specific HR activities. For example, we observe a dip in most HR activities in automotive companies after 2015, which seems to be related to Dieselgate. Particularly noticeable was the impact of changes at the management board level,

for example, CHRO Janina Kluge joining Siemens in 2015, CHRO Zhengrong Liu being hired by Beiersdorf in 2014, or CEO Kaspar Rorsted's work at Henkel and Adidas.

4 Conclusion

We cannot find a uniform correlation between digitization and HR activities. The reason for this is the different use of technology per HR activity. For example, the frequency of terms related to remuneration decreases with increasing digitalization. A reason for this could be automation processes that push this activity into the background. On the other hand, activities in the areas of organizational design and health management are increasing. Strong external influences affect the developments at the personnel, organizational and market levels.

In terms of general progress in the digital transformation, it can be said that the companies surveyed are developed surprisingly differently. The interviews with the responsible HR managers reveal a heterogeneous picture. Although all of the DAX companies surveyed are now looking into the use of modern digital technologies, implementation seems to be taking place on a rather selective basis. Manager report lighthouse projects and site-specific solutions. As previous empirical data suggests that HR activities support company performance significantly when in alignment, we recommend a more holistic approach to harness the benefits from digital technologies [36, 37].

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Clustering of Drivers' State Before Takeover Situations Based on Physiological Features Using Unsupervised Machine Learning

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Abstract. Conditionally automated cars share the driving task with the driver. When the control switches from one to another, accidents can occur, especially when the car emits a takeover request (TOR) to warn the driver that they must take the control back immediately. The driver's physiological state prior to the TOR may impact takeover performance and as such was extensively studied experimentally. However, little was done about using Machine Learning (ML) to cluster natural states of the driver. In this study, four unsupervised ML algorithms were trained and optimized using a dataset collected in a driving simulator. Their performances for generating clusters of physiological states prior to takeover were compared. Some algorithms provide interesting insights regarding the number of clusters, but most of the results were not statistically significant. As such, we advise researchers to focus on supervised ML using ground truth labels after experimental manipulation of drivers' states.

Keywords: Automated vehicles · Clustering · Machine Learning · Physiological state · Takeover · TOR

1 Introduction

Research on conditionally automated driving has been extensively conducted in the last few years. One of the main challenges is to optimize the interaction between the car and the driver, especially in situations of handover of control. When a takeover request

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 550–555, 2022.
https://doi.org/10.1007/978-3-030-85540-6_69

(TOR) is issued, drivers are expected to take over the control of the car in a short period of time and with the adequate behavior (e.g. braking and/or turning the wheel). The physiological state of the driver prior the TOR is critical and was shown to impact the takeover performance [1, 2], motivating the need to know the physiological state of the driver before triggering a TOR. This information could then be used to improve takeover performance. In previous studies, this has been addressed by experimentally influencing drivers' physiological states with the use of secondary tasks which was then used as ground truth information. To the extent of our knowledge, little was done on studying natural clusters of driver physiological states. Knowing the general state of the driver, meaning in which cluster they are, could be used to improve the takeover quality by adjusting the TOR to their state. As such the goal of this study is to find out if Machine Learning (ML) can be used as a tool to distinguish relevant clusters of drivers based on their physiological state before a TOR.

2 Related Work

2.1 Psychophysiological Data Clustering

The ML algorithms need to focus on the most relevant features and on coherent data only [3]. Furthermore, the Bayesian Information Criterion (BIC) score cannot be used with a dataset in which the number of samples are not considerably higher than the number of features extracted [4], which is the case in this study (108 feature for 304 samples).

As such, the mean and the standard deviation provide information about data distribution into a feature [3]. This can be exploited in the feature selection with a variance threshold.

Models of the driver's state are being studied, but they usually aim at classifying driver's condition using states that are manipulated experimentally [5, 6]. Other sources of data such as driving behavior [5] were shown to be valuable to classify the driver's state. Yet, this source of data cannot be used anymore in high levels of automation. Previous studies classified various drivers' states using physiological data, such as stress [7, 8], fatigue [9], or cognitive workload [6]. However, only few studies tried to perform unsupervised ML tasks using physiological indicators in such context [10, 11].

3 Methodology

3.1 Data Collection

Electrodermal activity (EDA), Electrocardiogram (ECG) and respiration (RESP) of 80 subjects were collected during an hour of conditionally automated driving in a driving simulator. Participants spent the first 5 min in autonomous mode monitoring the environment only. This phase was used as a baseline for the physiological state of each driver. Then, participants had to drive manually for 5 min, while the takeover process was explained and showed to them (three takeovers). The TOR was indicating by displaying a red icon on the dashboard and an audio chime. In the main driving session, participants had to perform a succession of non-driving related, cognitive demanding

tasks (N-back task) on a tablet held in hands while the car was driving. Participants were instructed to take over control of the car when requested. All participants had to react to 5 takeover situations due to an automation limitation. The cause of each takeover request was different but in the same order for all participants: steep road ahead and no visibility behind, vanishing and then fully erased lane markings, a rock on the driving lane, heavy rain, and a deer standing on the right side of the road and then crossing. There were 5 different tasks: visual low cognitive, visual high cognitive, auditory low cognitive, auditory high cognitive or no task (e.g. monitoring the environment). Each participant was completing all the five non-driving task in one driving session. The order of non-driving tasks presented to each participant was controlled using a Latin Square Design.

3.2 Physiological Features

The Neurokit [12] library in Python was used to process the 3 signals and compute physiological indicators. Different time windows before takeovers were used to calculate them: 30, 60, 90, 120 and 150 s. Each indicator calculated with Neurokit served as a feature for the clustering task. Also, an additional feature was created from each indicator: a baseline correction was applied to each indicator (e.g. subtracting the value of that indicator during baseline) in order to remove the individual differences of drivers at rest. Overall, a total of 120 features (10 for EDA, 27 for ECG, 19 for RESP, 4 for Respiratory Sinus Arrhythmia) were calculated using each time window before each takeover for the 80 participants.

3.3 Machine Learning

Outliers Detection. The Z-Score is used to detect outliers based on a Gaussian probabilistic distribution. For each feature, every samples with an absolute Z-Score strictly greater than 3 ($|\text{Z-Score}| > 3$), which corresponds to 3 standard deviations from the mean, are considered as outliers and are ignored for the following processes.

Features Selection. Since the dataset contains a large amount of features (108), it is necessary to select the most important ones. The Pearson correlation coefficient gives information about the linear relation between two features. Firstly, relations with a coefficient of correlation greater than 0.8 are removed. Removing a relation corresponds to remove one of the two features which are part of the relation. Finally, the Pearson correlation coefficient is used again to remove relations with a correlation coefficient greater than 0.8. The feature selection is made in two steps to keep as many features as possible.

Another avenue of research is using a variance threshold to select the features. However, this method has not provided better results than the one with Pearson correlation coefficient and was thus abandoned.

The total number of features kept for each time window is presented in Table 1.

Clustering Algorithms. The selected machine learning algorithms K-Means, EM-GMM, DBSCAN and Mean-Shift have been tested on this dataset, once outliers detection

Table 1. Total number of features kept in each time window after the feature selection process

Time window	30s	60s	90s	120s	150s
Final number of features	13	13	14	15	13

and features selection have been processed. All those algorithms hyperparameters were optimized using the methodology presented in the following section. The resulting clusters from these algorithms are then evaluated and compared in order to choose final hyperparameters and also the most efficient algorithm for this specific task.

Parameters Definition. With K-Means, the elbow method was used to estimate the optimal number of clusters. Then, to further refine the exact number of clusters, it was combined with the Silhouette score which informs about clustering quality. It was also further confirmed with the Mutual Information (MI) score, which informs about clusters' stability. Silhouette score and MI score range typically from 0 to 1, with 1 being the best score possible.

With EM-GMM, the BIC score is usually a good indicator to select the optimal number of clusters and the optimal covariance type. Since the number of features has been sufficiently reduced, it can be used on this dataset. Nevertheless, these supposedly optimal parameters do not provide the best results for the MI score or the Silhouette score. As every indicator provided different optimal parameters, multiple combinations have been compared with K-Means clustering.

With Mean-Shift, the parameter to define is the bandwidth. A finite field of bandwidths values (from 2 to 20) were tested until the algorithm clustered every sample into a cluster. For each bandwidth of the finite field, the population of every cluster as well as the number of clusters that it involves were checked.

With DBSCAN, the parameters to fine-tune are the maximum distance between two samples for one to be considered as in the neighborhood the other (eps) and the minimum of samples in a neighborhood to consider the neighborhood as a cluster (minPts). Two finite fields of values were created for both parameters. All the combinations between the values of these two fields have been tested until every sample was contained into a cluster or until most of the samples were considered as noise. For each combination, the population of every cluster as well as the number of clusters created were analyzed.

4 Results

Overall, Mean-Shift and DBSCAN were not able to achieve significant results, despite trying several configurations of parameters. For K-Means, a Silhouette score of 0.10 was attained (std: 0.00) and a MI of 0.8 (std: 0.1) using the 30s time window and 3 clusters. EM-GMM (spherical) presented two interesting clustering results, with a Silhouette score and MI of respectively 0.25 (std: 0.01) and 0.87 (std: 0.27) for the 60s time window, and 0.38 (std: 0.08) and 0.85 (std: 0.33) for the 120s time window, with 2 clusters each time. Both situations presented one cluster significantly smaller than the

other one 70 vs 255 (for the 60s) and 41 vs 291 (for the 120s). Also, we analysed if those two clusters match the 2 physiological states that were manipulated experimentally: no task (20% of the dataset) vs. task (80% of the dataset). After a comparison of the samples in each cluster, it appears that this is not the case.

In both situations, the models seem to gather more extreme values in a cluster (the small one), and keep the other ones in another cluster (the large one). As such, analysis of the features revealed extreme standard deviations in the smaller cluster, rendering further analysis unnecessary.

5 Conclusion

The current results show that there are no clear clusters of physiological data prior a TOR. Unsupervised ML algorithms were not successful in creating relevant clusters, despite testing several time windows. Bigger time windows and more refined features can still be tested, but our first results seem to hint that this is a difficult task.

As such, we advise researchers to focus on supervised ML using ground truth labels after experimental manipulation of drivers' states.

Acknowledgments. This work is part of the AdVitam project funded by the Hasler Foundation. We would also like to thank our colleagues who helped us during this project.

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Between 3D Models and 3D Printers. Human- and AI-Based Methods Used in Additive Manufacturing Suitability Evaluations

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Abstract. This paper presents the Additive Manufacturing (AM) evaluation methods and methodologies. A comparative analysis is conducted in order to categorize the methods according to different criteria. The comparison describes various approaches, along with their objectives and requirements. The emphasis is put on the aspects of automation and machine learning in the context of AM suitability evaluation. The aim of the article is to offer a high-level reference point for researchers who verify the potential of AM in the context of their studies or business activities. The comparison should facilitate the choice of an optimal, applicable method for identifying AM potential in a specific scenario. Additionally, the analysis offers an insight into the trends of the AM potential analysis methods, evaluating the role of AI and other aspects of Industry 4.0 in the field.

Keywords: Additive Manufacturing · AM selection · AM identification · Assembly consolidation · Topology optimization · Automation · AI · Machine learning · IoT

1 Introduction

1.1 Additive Manufacturing (AM) as a Cyber-Physical System (CPS)

AM is a method of making physical solid objects from digital models. They are built in a process, where successive layers of material are laid down in different shapes [1]. AM involves digital data processing which drives the machines commonly known as 3D printers. AM processes can be considered cyber-physical systems because the seamless, real-time interaction between the hardware, firmware and data is crucial for their successful operation. The hardware part is responsible for building the physical objects. Various technologies can be used to achieve this purpose, e.g. melting metal powders with laser scanners or selectively deposing thermoplastics extruded through a computer-positioned nozzle. The hardware is controlled in real time by firmware which simultaneously monitors the build process on various channels.

In order to coordinate the production process, the firmware requires a set of instructions based on a virtual 3D model. The 3D models need to fulfill technology requirements in order to become printed parts. The printed parts will have properties and quality

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 556–562, 2022.
https://doi.org/10.1007/978-3-030-85540-6_70

characteristic for the AM technology used. This leads to a demand for knowledge on how to evaluate AM potential, choose a suitable AM technology and design models in compliance with the rules of the chosen production method.

1.2 Introduction to AM Implementation Processes

In companies, the process of implementing AM often starts with a research oriented towards identifying the areas where AM could offer substantial benefits. The benefits are of economical nature, either directly (cost savings) or indirectly (developing a more competitive product which leads to higher revenues). The decision makers expect the research phase to result in clear, even binary indicators in order to approve AM implementations. The R&D teams need to consider various implementation scenarios and adjust them to the specifics of their businesses. Two following examples illustrate the diversity of the application fields. During an early phase of product development or improvement process, the product's KPIs could be already known and measurable. When a heat exchanger for an aircraft is developed, its working surface area must be as big as possible, while the device itself needs to remain compact and lightweight. This leads to a complex geometry of the device. Because of the efficiency AM provides in case of complex shapes, including this technology in the production workflow resulted in a more efficient process which delivered heat exchangers with a better performance [2]. A different scenario is when AM is used in procurement and service to re-supply out-of-stock parts. Re-introducing parts originally produced with injection molding can be expensive when the original molds are missing. When a small series of thermoplastic replacement parts is needed, AM allows to produce them without molds. From the Total Cost of Ownership (TCO) perspective, savings on the production costs can be significant [3]. Due to the high variety of possible applications, benefiting from the AM technologies requires a deep knowledge. This knowledge is vaguely catalogued. The common sources of knowledge are: academic researches, publications on successful applications, AM system developers, AM experts and consultants working in different industries, product designers and managers, AM service providers and many others. The knowledge consists of aspects related to the capabilities (and limitations) of the AM technologies and economical drivers justifying their usage across various industries. A successful application of AM rests heavily on the human expertise [4]. Some of the experts operate based on sets of learned opportunistic good practices, rather than documented methodological approaches. However, AM evaluation methods and methodologies are being constantly developed and they vary between general design guidelines and fine-tuned assessment algorithms involving artificial intelligence (AI). Since the variety of the application scenarios is extensive, it is important to consider organizing the available AM evaluation methodologies, methods and tools into a versatile catalogue. The catalogue could be then used as a handbook to easily identify which AM evaluation approach is the most suitable in a given scenario. This paper aims to summarize various aspects of categorizing the methods and methodologies. Those aspects could then be applied to structure the catalogue. Examples of categorized methods are given to illustrate the proposed categories.

2 State of the Art

The proposed categories are targeting the AM consumers, e.g. designers, product owners, production engineers, AM consultants etc. The discussed topics are influenced and restricted by the AM build process requirements. However, optimizations of AM build processes (e.g. build orientation, support structures and other) are excluded from the paper's scope. Given a CAD model adjusted to AM requirements, its print process parameters could be considered not directly related to the AM suitability evaluation. Similarly, the work does not focus on the development of the AM technologies, but rather on the methods which take advantage of the documented potential of AM.

2.1 Design for Additive Manufacturing (DfAM) Guidelines and Tools

DfAM is understood as "a set of methods and tools that help designers take into account the specificities of AM (technological, geometrical, etc.) during the design stage" [5]. Methods and tools purposed mainly for designers who tackle the challenges of product development are considered DfAM in the strict sense. Pre-conditions are: the user of the method has a general understanding of how and why AM can improve their product and business; additionally, the method's user needs to have a direct influence on the product's design. This category hosts: good practices on how to design three-dimensional (3D) computer-aided design (CAD) models so that they are compatible with a chosen AM technology; software tools with implemented restrictive rules to check existing 3D CAD models for compatibility with given AM technologies; topology optimization software whose purpose is to significantly reduce the volume of the existing 3D CAD models with a minimum impact on their performance. Other knowledge aspects around DfAM involve design for mass customization, lattice structures, assembly consolidation and material/process selection. It is worth mentioning, that DfAM guidelines and tools can take multiple forms, including commercial solutions: static content (manuals, instructions, books [6]), online applications capable of verifying CAD model against given AM technology requirements [7], workstation software suites and modules dedicated to AM optimization, online databases with AM systems and materials [8].

2.2 Systematic Selection Processes

Another approach to AM evaluation is to screen large inventories of parts or AM processes-material combinations in order to identify the potential gains. Screening methods could be useful mostly for R&D departments and business owners, because they can direct the attention towards the promising areas, when no previous work has been done on the topic. Prerequisites: databases of parts need to contain the information required by the chosen selection process. The process often requires the data to be compiled from different sources, including CAD files and databases from Enterprise Resource Planning (ERP) or Product Lifecycle Management (PLM) systems.

In the majority of screening projects the amounts of data to be assessed are large and automation of the processes is highly advised. The simpler methods include filtering rules which can be effectively executed in a spreadsheet. An elemental example could be a restrictive rule which rejects the parts that are too large for a given AM technology.

In practice it could take a form of a simple column filter which hides rows where at least one of the XYZ dimensions of the part exceeds the pre-defined size limit. Another example brings up a sorter which highlights parts sourced from the most problematic supply chains.

Such assessments offer basic overview of the inventory and require experience and creativity in order to design a proper screening setup. They can be applied in multi-disciplinary teams which consist of members with deep understanding of the company processes and external AM experts. Various ideas have been proposed in order to streamline such processes into universal frameworks. Christian Lindemann et al. propose a two-pass process in which the inventory is first screened for the promising candidates. The results of the first step are then evaluated by experts [9]. Nils Knofius et al. develop a scoring method which assigns technological and economical suitability scores to the inventories of parts used in service logistics [10].

Other authors adapt multi-criteria decision making (MCDM) methods successfully used in conventional manufacturing, in order to identify the most promising material and process combinations for a given part. Uzair Khaleeq uz Zaman et al. have developed the Integrated Product-Process Design (IPPD) method based on Ashby's material selection charts and Analytical Hierarchy Process (AHP) [4].

2.3 AI-Enabled Tools and Methods

The systematic selection processes described above are procedural in nature. In their case, the role of information technology (IT) tools is to offer automation. and fast execution. Large numbers of database records rely on fast execution in order to consider a method efficient. The procedural algorithms include computation formulas and conditional flow control. The tools deliver reports which serve as the decision material.

Artificial Intelligence (AI) is an intensively developed field which brings new ways of using computer systems. Among them there are forms of AI which have been involved to help in AM suitability evaluations. Yuan Bin Wang et al. review various applications of AI in AM [11]. In their work, the authors analyze multiple intelligent agents used in product design, process design and production.

One of the AI concepts adapted for AM is machine learning (ML). Training models are developed to offer smart, self-managing AM systems. A limitation stressed by Sheng Yang et al. is that the availability of training-suitable AM datasets remains low and the cost of data acquisition is high [12]. It seems that in their current stage of development, the smart systems are used mostly in process design and production monitoring. A possible reason for this tendency is that the domains of AI-managed parameters in production planning and monitoring are easier to define than in case of the part selection and evaluation. Another possibility is that data mining for process planning and execution can benefit from the gradually growing history of successful AM executions. A single virtual 3D model can be printed multiple times with various parameters, allowing the data miners to train ML systems on various cause-effect relationships. This could lead to AI applications capable of finding optimal planning and execution parameters.

Although the AM part selection and evaluation processes can pose a challenge for developing an AI system successful in this field, such solutions have been proposed and functional prototypes have been tested. Sheng Yang et al. have proposed a decision

support system (DSS) based on the Boosted Decision Tree Regression (BDTR) algorithm [12]. The prototype has been tested in a cloud-based framework and offered as an open-access tool [13].

Yi Xiong et al. propose a versatile solution working in the design exploration field of DfAM. The authors define design exploration as "searches for a set of potential solutions to meet design targets that are defined by a set of ranges rather than specific values" [14]. In the approach, a data-driven method is used in design optimization tasks. In a training data set, high-fidelity models are replaced with their input-output behavior equivalents. This simplification opens a way to faster data processing which delivers competitive results.

2.4 Value Clusters

In their works, Filippo Fontana, Christoph Klahn, Mirko Meboldt et al. identified a set of seven value clusters offered by AM [15] and associated the clusters with different DfAM strategies to investigate the value creation and the design process [16]. The clusters are related to new product development process (prototyping, incremental product launch, better product, custom product) and order fulfillment process (process concentration, production tools, improved delivery). The authors highlight the possibility to group the DfAM activities into two design strategies: function-driven design strategy and manufacturing-driven design strategy [17]. The variety of existing AM selection approaches is emphasized and connected with value clusters and design strategies. This approach offers a quick orientation in the methods used for identifying parts and applications for AM. The value clusters along with the design strategies could serve as potential categories to group the identification methods. This categorization allows to catalogue both mental tools and IT solutions.

3 Proposed Set of Requirements for an AM Evaluation Method Catalogue

Different scopes of AM part evaluation have been highlighted in previous sections. The given examples of methodologies, methods and frameworks illustrate the variety of available tools. It could be beneficial to collect the entities into a database which would provide structured information on different approaches to AM potential assessment. The database could be cloud-based in order to provide easy access through different devices. An API could be implemented in order to facilitate integrations with other systems, including the Internet of Things (IoT) networks.

The main functionality of the database should allow to browse the records, by means of search and filter functions. The entities could be grouped into main categories, including but not limited to the ones mentioned in the section no. 2. Defining special attributes characteristic for certain AM application scenarios would allow to select sets of methods compatible with the user's assets.

Each methodology, method and tool would have its unique set of elemental requirements. The sets of requirements could be formatted into matrixes. One could simulate an example scenario in which a user wants to evaluate the AM implementation for his

company. The user fills a form in which he/she provides a structured landscape of his assets. His submission informs the system on the facts that the user has a complete ERP information on his parts, his main objective is to reduce lead time for production line spare parts, but the user's company does not own the designs of the parts. In the next step the system would query the database according to the user's profile and retrieve a list of evaluation methods which would be the most efficient ones in the given scenario.

The proposed tool would substantially reduce the time needed to find a proper AM evaluation method.

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A Human-Human Interaction-Driven Framework to Address Societal Issues

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Abstract. The scientific contribution of this paper is a multilayered Human-Human Interaction driven framework that aims to connect the needs of different sectors of the society to provide a long-term, viable, robust, and implementable solution for addressing multiple societal, economic, and humanitarian issues related to the increasing population of the world. 'Connecting dots' here involves issues of three major constituents of the society: the loneliness in the rapidly increasing elderly population, the increasing housing needs of low-income families, and caregiver shortage. The proposed framework would facilitate mutually beneficial, sustainable, equitable, and long-term solutions, based on several factors, to address these global societal challenges. The development of this framework involved integrating the latest advancements from Human-Human Interaction, Big Data, Information Retrieval, and Natural Language Processing. The results presented and discussed uphold the significance, relevance, and potential of this framework for addressing these above-mentioned societal issues associated with the increasing global population.

Keywords: Human-Human Interaction · Big Data · Information Retrieval · Natural Language Processing · Elderly population · Loneliness · Societal issues

1 Introduction

The world's population has been increasing at an unprecedented rate [1]. Currently, at 7.9 billion [2], the global population is projected to become around 12.3 billion over the next few years [3]. This increasing diverse population of the world leads to a multitude of societal, economic, and humanitarian needs and creates an interlocked crisis amongst people, resources, and the environment [4]. Better healthcare facilities, advancements in medical research, declined fertility rates, and increased life expectancy [5] has resulted in an immense increase in the aging population of the world, which has caused a "demographic transition" [1] in the population in different countries. For instance, 28.2% percentage of Japan's population is aged 65 or more [6]. The total number of elderly people worldwide currently stands at around 962 million [7], which is projected to outnumber the population of younger people in the next few years [8].

Loneliness, a serious lack of supportive/positive/constructive human interrelationship due to social isolation, has various short-term and long-term psychological and

© The Author(s), under exclusive license to Springer Nature Switzerland AG 2022
T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 563–571, 2022.
https://doi.org/10.1007/978-3-030-85540-6_71

physical effects on the elderly, like, depression, anxiety, obesity, weakened immune system, and can even lead to death [9]. Loneliness is a major challenge associated with the increasing aging population and has been defined as an "epidemic" for the elderly [10]. According to [11], 43% of older adults feel lonely, and it causes a 59% greater risk of decline in the elderly. The loneliness of the elderly population is not the only problem that societies and communities face in today's world.

Finding affordable housing for young families in the lower-income strata is becoming a global concern. There is a direct relationship between housing and the health of its tenants. Housing has been defined as a "basic necessity" of an individual [12] as housing is associated with a proper shelter; supply of food, water, and basic amenities for survival; supporting of physical, psychological, mental, and emotional well-being; and protection from diseases and disasters. With a lack of affordable housing, lower-income families are forced to strain their financial resources to the limit to pay high rents leading to huge amounts of debts [13]. The absence of affordable housing for this sector of the population also causes instability in their livelihood as they are forced to move frequently, resulting in homelessness [14]. The percentage of low-income families who experience homelessness is increasing exponentially in different parts of the world. In the United States alone, annually, around 2.3 million people and 1 million children experience homelessness for such reasons [14]. Such families seek a stable environment as an entry point into a proper neighborhood to raise their families and for opportunities for their young children [15]. To add to homelessness, the rise of caregiving costs for children is also a major challenge for low-income families across the world [16]. This rise in the cost of caregiving, expected to double by 2050 [17], is associated with the decreasing population of caregivers. The caregiver ratio is expected to decrease to 2.9% by 2050 [18]. To add, overworked caregivers quite often do not provide a quality service to address the needs of the infants and children they serve [19].

There have been several works done in this field. Still, these global challenges involving issues of these three major constituents of the society remain unaddressed. Recent works [20–24] related to loneliness in the elderly have focused only on discussing the multitude of factors that lead to and affect loneliness in the elderly without addressing them. Increasing opportunities for the companionship of the elderly by extending the existing paradigms of human interrelationship is much needed. Similarly, works [25–29] related to the need for housing and caregiving of children for low-income families have also lacked at providing any implementable solutions for these issues. Established households offered by elderly residents could play a pivotal role in a holistic solution. The contribution of this work is to use recent advancements from various disciplines to provide the ability to connect the various issues that are currently in 'silos' and explore viable solutions. We present a means for addressing the aforementioned societal issues. Using the first layer of this multilayered framework, elderly people, who reside alone in different geographic regions, have been identified [29]. When capable and properly vetted, allowing the elderly to join a community for interacting with and reaching out to another societal sector in need holds the potential to be a good humanitarian initiative. In this paper, a second layer is developed to identify another demographic group of people, the low-income young families with demonstrated housing needs or caregiver needs in the same geographical regions of the specific elderly group. This paper is organized as

follows. Section 2 provides an overview of the associated methodology towards developing this functionality in the framework. The results and discussions are presented in Sect. 3, which is followed by a conclusion and scope for future work in Sect. 4.

2 Proposed Work

Being able to communicate is an important human need. As technology is seamlessly integrated into our lives, face-to-face communication among people has changed and evolved into various synchronous and asynchronous formats based on computers and smart mobile devices. While both the very young and the elderly are still struggling to adapt to the ever-changing and complex gadgets and systems, it is fair to say that most of the population is doing more communication via a virtual medium rather than in-person [30]. The ability to communicate, using whatever technology presently available, forms an essential foundation for our discussion of the development of the social support system for an individual, which addresses social ties, relationships, and multiple resources – including physical, emotional, and informational resources that directly or indirectly affect the quality of life of an individual [31]. Social media has transformed the way people develop their social support systems, to be precise, 'online' social support systems these days. The 'virtual world' created by social media networks provides a sense of connectedness and belonging through the ease of communication, increased opportunity of developing new ties, and means to foster existing relationships at the fingertips – which has seen the rapid increase of users on social media and similar virtual mediums of communication. In the context of social media, Twitter, a microblogging service in the social networking world, has a global reach and is used by millions of people daily for a varied range of communications, including discussion on various issues, news, information sharing, conveying needs, seeking solutions to different problems and networking, just to name a few [32]. Young people are frequent users of Twitter [33]. Twitter communications can include tweets about a range of subjects, the discussion of needs, in this context – housing and caregiver needs of low-income families would also be one of the subjects of conversation in the 'virtual world' of such families as they communicate with their 'online' social support systems on Twitter. Developing a pertinent ontology and filtering such communications, harvested from the world of Big Data, to further study these families' needs is relevant for developing this functionality in the framework.

So, we used a Big-Data centric Information Retrieval approach that used Natural Language Processing to mine relevant communication patterns and information trends on Twitter for identification, analysis, and interpretation of such housing needs expressed by low-income families. We also studied the user's details with a specific focus on the user's geographic location for connecting them to the elderly in that location identified by layer 1 of our framework. We used RapidMiner [34], a data science tool, that provides many of these functionalities, which are customizable and can be easily integrated. In RapidMiner, such applications are known as "processes", and each component of a "process" that represents a specific functionality is known as an "operator". The steps associated with developing this layer included – (1) Develop a bag of words model, which would act as a collection of keywords to identify tweets related to housing and caregiver

needs. (2) Develop a "process" in RapidMiner using the 'Search Twitter' "operator" that uses its Twitter Connection to search recent tweets which match the keywords from Step 1. (3) Perform filtering of tweets obtained from Step 2 to eliminate tweets that might be advertisements, promotions, or similar, which are not required for this study. (4) Filter out unwanted attributes from the results to have only the tweets and other essential information. (5) Track the Twitter ID and username of each Twitter user from the list of tweets obtained after the filtering process. (6) Develop a "process" in RapidMiner using the 'Get Twitter User Details' "operator" that uses its Twitter Connection to search for details of the user, including their geographical location (when publicly listed on their profile). (7) Filter out unwanted attributes from the results to retain only the necessary information. (8) Repeat Steps 6 and 7 to compile this information for all Twitter users identified by Step 5.

3 Results and Discussions

Based on the steps outlined in Sect. 2, we developed layer 2 of this framework. For developing the bag of words model, we used multiple keywords related to and conveying the same meaning as housing needs and caregiver needs. For instance, words like "homes", "home", "house", "houses", etc. followed by "need" and "needs" were used to filter tweets consisting of housing needs. Figure 1 shows the "process" developed as per Step 2 above, where we searched for tweets using one of the combinations of these keywords – "housing needs".

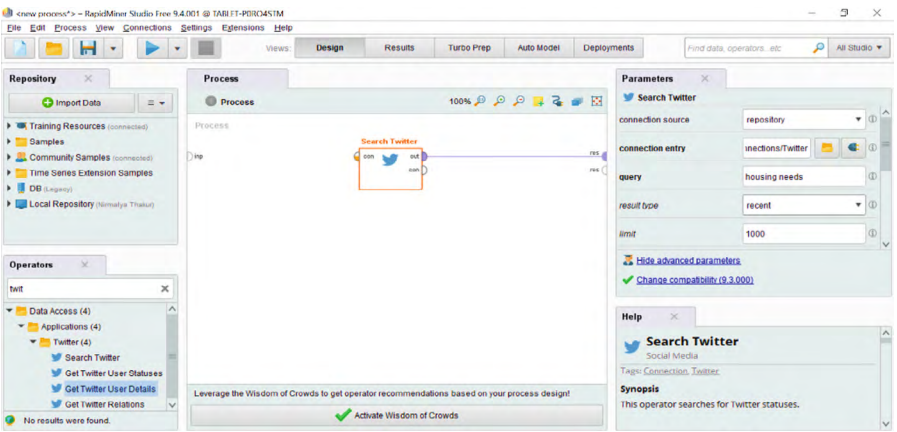


Fig. 1. The "process" developed in RapidMiner by using the 'Search Twitter' "operator"

As shown in Fig. 1, the 'Search Twitter' "operator" of RapidMiner comes with the feature to look up tweets on Twitter based on keyword search. The parameters section on the right allows the user to define these features as per the specific needs. In this context, we provided the keywords – "housing needs" in the 'query' section instructing RapidMiner to look up for tweets that consisted of these keywords. Also, in

the ‘result type’ section, we specified ‘recent’ to only look up recent tweets. The ‘limit’ section allows limiting the search results. We provided 1000 to filter out the 1000 most recent tweets. After implementing the filtering methodologies outlined in Steps 3 and 4, we obtained this set of tweets. A screenshot of the same is shown in Fig. 2. Next, we implemented Steps 5, 6, and 7 towards tracking the user details. We developed a “process” in RapidMiner using its ‘Get Twitter User Details’ as shown in Fig. 3.

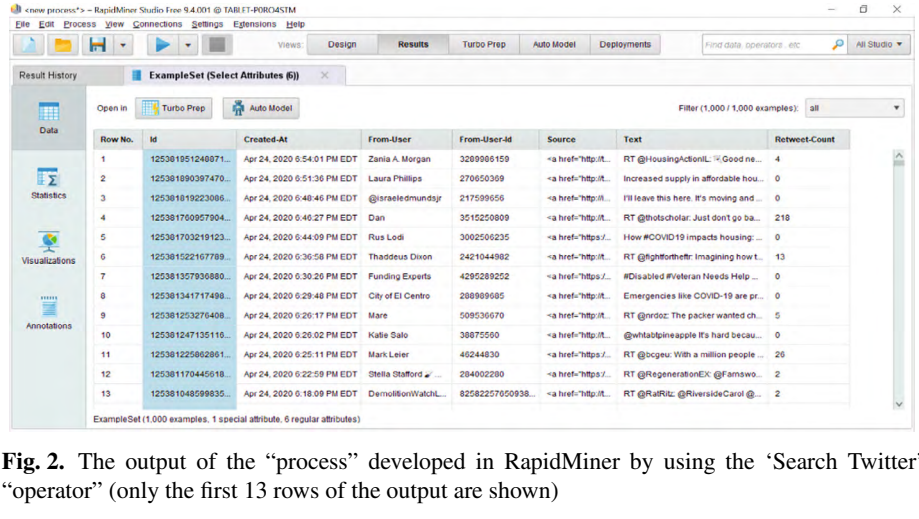


Fig. 2. The output of the “process” developed in RapidMiner by using the ‘Search Twitter’ “operator” (only the first 13 rows of the output are shown)

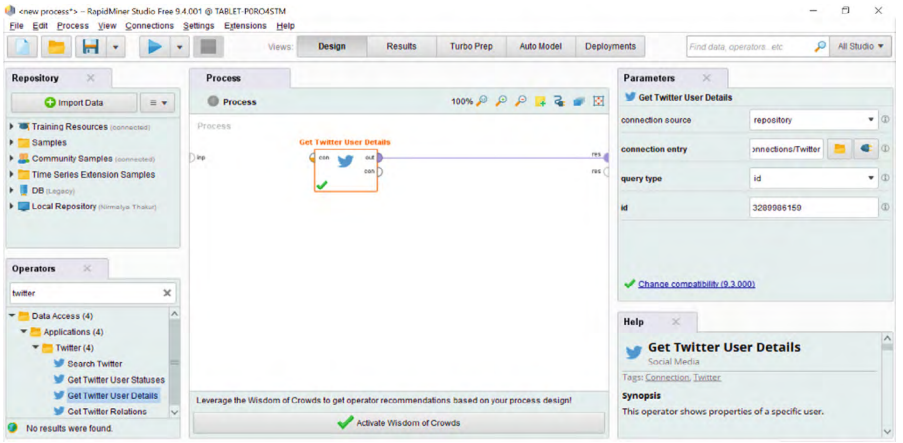


Fig. 3. The “process” developed in RapidMiner by using the ‘Get Twitter User Details’ “operator”

The ‘Get Twitter User Details’ “operator” of RapidMiner allows looking up for details about a Twitter profile based on either the profile name or the Twitter ID, provided one or more details associated with the account have been made public by the Twitter user. We decided to choose the Twitter ID for looking up these details as it is a unique

identifier for each Twitter user. So, in the 'query type' section, we mentioned "id" and provided the different users' ID's from the results table, as shown in Fig. 2. This "process" for the first user from the results table of Fig. 2 is shown in Fig. 3, and the results are presented in Fig. 4. In the context of these results, the 'Location' attribute is most important to us. Twitter allows every user the option to hide or protect different information associated with their account [35]. The above user had chosen to make all the information, as shown in Fig. 4, public, so we could obtain and present the results. Similarly, the details of other users were tracked, and their locations were noted and compiled. Those users identified from the results table shown in Fig. 2, who had chosen to hide or protect their information, specifically their location, were not included in this study. This location information associated with an account helps us identify families who have housing or caregiver needs in different locations or areas worldwide so that they can be connected to the elderly people in the same area who are currently staying alone, as identified by layer 1 of this framework [29].

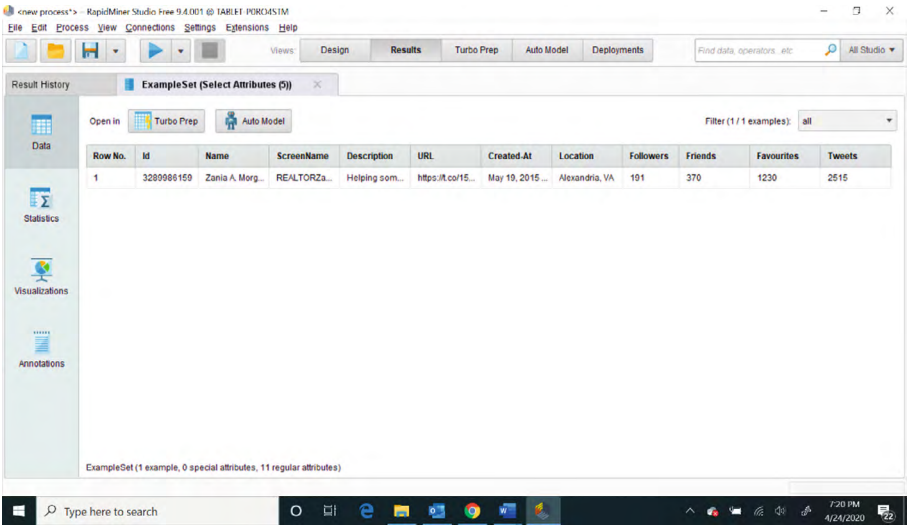


Fig. 4. Results of the "process" developed in RapidMiner by using the 'Get Twitter User Details' "operator" (for one specific Twitter user)

4 Results and Discussions

The work presented in this paper involved the development of the second layer of our Human-Human interaction driven framework, introduced in [29], to address loneliness and social isolation in the elderly, as well as housing needs and caregiver needs for children, demonstrated by low-income families. The second layer uses recent advancements from several disciplines such as Big Data, Information Retrieval, and Natural Language Processing to study Twitter data to identify such families in different regions of the world

who have demonstrated such needs through their tweets. The results presented and discussed here uphold the relevance and potential of this framework to address the societal, economic, and humanitarian challenges associated with these three major constituents of the society in view of the unprecedented increase of the world's population. As per the authors' best knowledge, no similar work has been done in this field yet. Future work would involve developing the third layer of this framework. The third layer would comprise the approach that develops mutually beneficial, sustainable, equitable, and robust connections between the elderly and the low-income families identified by the first and second layers, respectively. It would also consist of a fitness of matching algorithm that considers multiple characteristics of both the elderly and these low-income families, including their diversity and social compatibility, to compute the percentage match for any two of them. A higher value of the percentage indicated by this algorithm would indicate a better match. The work towards developing the third layer and the associated results would be presented in a subsequent publication.

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Who Are the Stakeholders of Drone Use? Roles, Benefits, Risk Perceptions, and Solutions

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Abstract. Drone technologies are now increasingly paving their way into commercial application with a promise of facilitating traditional operations. With the foreseeable increase in use of drones across multiple sectors and with rising concerns associated with drone flights, there is a need to perform stakeholder analyses for commercial drone usage. Based on the data collected from 15 expert interviews, literature search and a workshop, this paper presents a framework of actors who impact on or are impacted by the use of drones. It illustrates how the identified stakeholder groups could potentially benefit from drones, mainly economic, societal and environmental advantages, and on the other describes the challenges and concerns from the view-point of each stakeholder group. The findings reveled that safety is regarded as a high concern, however does not appear to be a principle concern for industry users and the overflown communities. The performed analysis points out that among the categorized stakeholders, overflown communities are perceived to have the highest opposition towards drone use. We conclude with discussing solutions on how to mitigate their concerns so as to facilitate increased social acceptance of drone usage.

Keywords: UAV · Drone Use · Drone Stakeholders · Stakeholder Analysis

1 Introduction

The advancements in drone[1] capabilities along with the growing global establishment of legislations has resulted in its increased usage in the past decade with a promise of significant growth in the near future. This new market has opened doors to advancements in automation, increase in opportunities for more optimized, safe and efficient operations across diverse domains, creation of job new sectors and even transformation of the concept of mobility and transport.

Despite the foreseeable advantages, all emerging technologies come with their own set of challenges and for their successful use, it is necessary to recognize these possible risks and overcome obstacles at an early stage. In the case of drones, it is critical to achieve acceptance by the users, authorities and in particular the overflown communities.

[1] Also referred to as Uncrewed Aerial Vehicles (UAVs) with more development of autonomous/non-piloted drones.

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 572–579, 2022.
https://doi.org/10.1007/978-3-030-85540-6_72

Identifying the people involved in drone use scenarios and understanding how they are influenced, whether positively or negatively, is a stepping-stone towards strategizing the best approach for the adoption of drone technology. There has been limited research investigating stakeholders involved in drone use. A recent paper by [1] showed that different stakeholders have different perspectives and attitudes towards the usage of drones. [2] investigated drone use in delivery and building inspection, and discovered how laypeople feared violation of privacy whereas drone pilots were mainly concerned with risks of possible accidents.

The current study aims to explore the ecosystem of stakeholders further. This paper describes the methods and findings of a stakeholder analysis performed within the context of the EU project ADACORSA encompassing three primary use case scenarios: delivery, smart construction and forestry. The study attempts to answer the following research questions: Who are the stakeholders for usage of drones? What are the primary benefits, challenges and concerns for each stakeholder?

2 Method

We performed a stakeholder analysis using a three step iterative process which takes up elements of the Delphi method. In step I, a total of 15 online interviews (approx. 60 min each) with 22 industry experts were conducted. These included first- and second-tier technology developers and system integrators, drone manufacturers, user/end-user consultants, industrial regulations and certification consultants, and drone operators. The semi-structured guideline was founded on the new technology acceptance model proposed by [3]. [3] discuss how perceived risks and perceived benefits have a direct impact on attitude as well as intention towards the technology. Thus, to understand attitude towards drone use, the collected data was analyzed to i) identify stakeholders; ii) differentiate between and categorize stakeholders; iii) investigate the challenges and benefits of stakeholders, and iv) determine the stakeholders' position and derive mitigation solutions. In step II, findings from recent literature were incorporated to strengthen the analysis. In step III, the results of the analysis were presented to 13 of our participants in a two-hour workshop with the goal of adjusting/identifying any gaps and inconsistencies. The workshop procedure included a presentation phase, a review phase, and a creative phase where participants actively took part in structured tasks. The aim was to encourage discussions and idea generation both individually and in groups. The three step method provided an in-depth assessment and resulted in a new proposed framework of the identified stakeholders.

3 Findings

3.1 Stakeholder Identification Framework

Based on the information collected, we assessed the list of actors and clustered them into five major categories (see Fig. 1). Specific placement within a category was determined based on their primary role and function however might entail interchanging roles. A drone-use stakeholder is defined as 'an individual, group, or organization who has

an interest or some stakes in, can contribute in the form of knowledge or support, or can impact or be impacted by, the use of drones (modified from [4]). The identified stakeholders have been classified into:

Development and Production stakeholders are experts in developing, designing and manufacturing drone technologies while ensuring safe and secure state-of-practice drones as per the set requirements. Research institutes and research projects contribute to the specifications of the new technology by expanding knowledge, evaluating outcomes and providing recommendations.

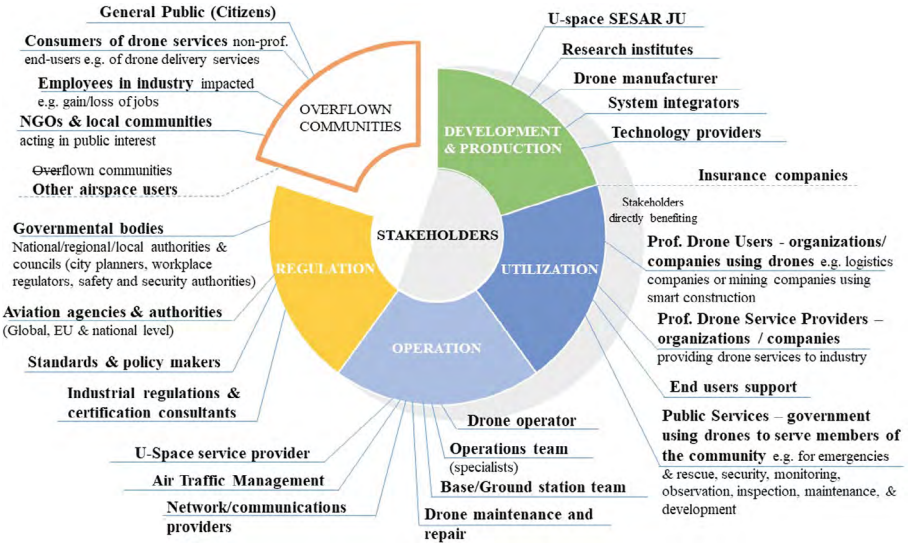


Fig. 1. Drone-Use Stakeholder Framework: Actors are classified as per five stakeholder categories based on their roles and functions.

Utilization stakeholders can be defined as 'professional-users employing drones'. These consist of individuals, companies or organizations who use drones as an instrument for business purposes to pursue their economic objectives. We identified two main types of users 1) those utilizing drones to increase productivity and efficiency of operations and/or expand their current services e.g. by offering drone delivery services, and 2) those providing drone-based services to the industry e.g. drone-based logistics service provider to transport goods or drone-based construction service provider offering building inspections via drones. Another important user identified are government and public service agents who would deploy drones to better serve members of the community e.g. police surveillance drones will increase safety and security and reduce crime-rates.

Operation stakeholders are all those directly involved in the operations of drone flights. These include 1) individuals and teams operating drones as individual entities or as part of utilization companies, 2) and other stakeholders who develop and oversee systems and services which ensure safety through the coordination of unmanned and manned flights on ground level and controlled airspace.

Regulation stakeholders are all agencies and authorities (global, EU, national level e.g. EASA and sister organizations) and regulatory consultants whose responsibilities include establishing regulatory frameworks as well as building standards and recommending guidelines such as setting boundaries and conditions for drone flights, governing and regulating civil aviation legal frameworks for instance carrying out certifications like drone operator licensing, and enforcing compliance. Lastly, all governmental bodies concerned with local authorities including local councils, municipalities, city planners, work-place/occupational health and safety, safety and security authorities e.g. police, fire brigade, etc. would have a high influence on commercial usage of drones.

Overflown Communities stakeholders refer to the general public. Four distinct groups are created to showcase people with specific roles within society who can be affected differently by drone use 1) individuals or communities in society i.e. citizens, 2) consumers (can also be referred to as non-professional end-users) who opt for drone services e.g. priority delivery, 3) employees or workers who would be directly or indirectly impacted in their professional life e.g. gain/loss of jobs, and 4) NGOs and local communities that are acting in the interest of the general public.

3.2 Stakeholder Benefits Assessment

Drones appear to not only bring high economic value for the industry but also significant social values that will benefit all. In the interviews, we explored these advantages for each stakeholder group. Interview experts' inputs resulted in an aggregated benefit framework consisting of primarily economic, societal, and environmental benefits.

Economic Opportunities. Industry-related stakeholders are clearly perceived to gain economic payoffs as a main benefit. The new market is expected to create revenue with higher returns, diversify and enlarge the customer base of drones, and boost the overall economy. Development and production stakeholders, when broadening the scope of drone-capabilities with the help of regulation stakeholders such as more robust and autonomous operations, would benefit from the expansion of the drone market. Utilization stakeholders would see drones as a practical and effective commercial tool across various applications (construction, mining, agriculture, forestry, infrastructure, transport and delivery etc.) that will facilitate more optimized, safe and efficient operations. For example, aerial imagery, mapping and surveying drone-based technologies will significantly reduce efforts compared to traditional methods e.g. less field work, provide new viewpoints and data (aerial-view perspective) and facilitate faster and more accurate analysis. This will reduce costs and resource consumption, improve efficiency and effectiveness, facilitate faster and more informed decision-making and management activities, and lastly result in higher customer/client satisfaction.

Societal Benefits. It is expected that the use of drones would potentially improve society's i.e. members of the overflown communities' quality of life. The new job market will create more high-end jobs and decrease lower paid jobs thus enhancing overall standard of living. The improved workplace safety conditions will significantly reduce occupational health hazards (e.g. not having to climb scaffoldings to inspect a tower). Moreover, transport drones are perceived to increase mobility options for consumers

for instance residence of thinly populated regions, rural areas, islands and mountainous regions will gain greater access to a wider range of services such as same day delivery, availability to a green delivery option or elimination of human contact e.g. in last mile delivery during pandemics such as Covid-19. Furthermore, numerous studies and articles as [5] have demonstrated the usefulness of drone usage in the aid sector e.g. transport of urgent medication or blood, search and rescue in areas that are difficult to reach, during natural calamities and disasters for humanitarian purposes etc.

Environmental Advantages. A clear benefit of logistic drones is the removal of vehicles from the road, in particular in high-populated urban areas, which could lead to decreased vehicles from roads, reduced traffic congestions, travel-time, and more importantly greenhouse gases. Similarly, in agriculture and construction using electric-powered drones rather than heavy high-fuel consuming machinery will reduce the impact on the environment (energy saving, low carbon and other pollutant emissions). One of the greatest advantages seen is the replacement of helicopters for instance often used to generate bird's-eye view and overhead shots in film and media production. Drones are today also being effectively utilized by conservationists for tracking wild-life, mapping forests, assessing damage to soil etc. which would facilitate forest health care. With clean energy, drones can bring us closer to attaining future green and sustainable development goals. Having said that, drone-based operations are indeed perceived to be more environmentally friendly but research shows that this depends on multiple factors such as how and where drones are deployed. [6] discussed how delivery drones are suitable for short trips with light-weight items whereas ground vehicle are more suitable for heavier items in long distance.

3.3 Stakeholder Risk Perceptions, Challenges, Concerns

Interviewees highlighted and prioritized the differences in the challenges and risk perceptions of the stakeholder groups. Subsequent weights (3 being very high concern, 2 high concern, 1 moderate concern, and 0 for low concern) provided by the analysis team were then used to quantify the data. Figure 2 illustrates the aggregated results. The size of the dots is the sum of weights assigned based on the individual inputs from the 22 experts (range 0–31). As shown in Fig. 2, safety-related concerns (ground risks, i.e., risks related to persons and objects on the ground, air risks, i.e., risks related to other traffic in the air) dominate and are a high priority for all stakeholder groups. However apart from this obvious result, the analysis showed distinct differentiations among the stakeholder groups.

As per the interviewees, development and production stakeholders on one hand have to meet the tough safety regulatory requirements and conditions, adhere to the policies and standards with respect to quality, operations, practice and process, and complete all necessary product verifications. On the other hand, they are required to develop a robust tech that would enhance workflow, enable fast operations, and provide value-added services (e.g. flawless data), that is able to be commercialized as well as satisfy the user's needs. The users' i.e. utilization stakeholders' perception of risk is associated with the overall efficiency and effectiveness in terms of reliability of the

novel technology when compared to traditional processes. Additionally, the solutions might not complement existing machinery or systems incurring in high investments or are not an attractive instrument for their business. Insurance and liability was perceived as a larger issue in certain application areas such as the delivery scenario due to close operational proximity to the general public. Other concerns such as rapid advancement rate, low return of investment, lack of or insufficient drone infrastructure, and risk of poor public image for instance in case of accidents were additionally recognized. Operation stakeholders involved in the direct use of drones are regarded responsible for the safe and efficient flights, communications and ensuring a safe air space.

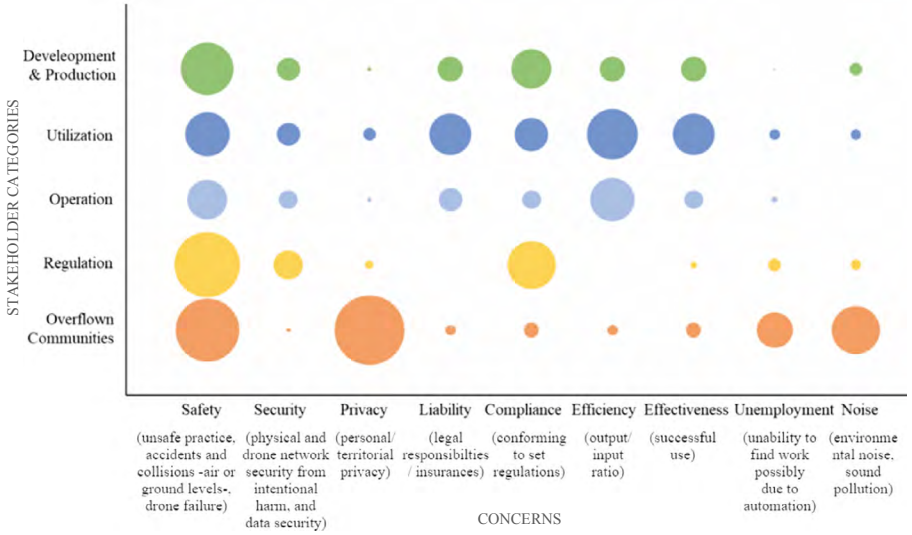


Fig. 2. Prioritization of concerns for each stakeholder group. Larger dots indicate a higher concern in relation to the displayed list of identified concerns (x-axis) for the respective stakeholder group (y-axis).

Regulation stakeholders have a high stake in the safety of the general public, workplace safety, air traffic safety, safety of other airspace users as well as security concerns such as cyber breaches that may lead to safety issues. This applies even more for drone flights around protected areas such as infrastructure, power plants and airports. They are the main contributors in issuing legal regulations and are responsible to have the right regulations in place and maintaining compliance, thus making it their primary focus.

Lastly, a finding that has been consistently reported across numerous studies like [1, 2, 7] is the overflown communities' concern for privacy. This includes risk of being filmed and recorded through the drone cameras, risk of pictures being taken, feeling of being observed or monitored resulting in discomfort due to invasion of personal privacy when drones fly close to a person or their home. In our interviews, we found privacy concerns overlap with security concerns with regards to confidentiality of personal data. For e.g. customers of a delivery service receiving parcels might be anxious about drones using personal data for targeted advertisements. Safety concerns were directed more

towards individual safety i.e. collisions to persons or objects falling from the sky and causing damage to property such as cars. Finally, apprehensiveness towards the drones' loud irritating noise especially in residential and sensitive areas (hospitals, schools) and unemployment distress due to automation are two growing issues for the overflown communities. Other identified challenges and concerns include wildlife and nature conservation; effect on/harm to birds, animals, trees, drone 'pollution'; disturbances, distractions and inconveniences caused due to high drone population e.g. drone swarms, concerns regarding waste, recycling, and sustainability, and ethical procurement; fear for misuse/inappropriate use of drones.

3.4 Position Analysis and Mitigation Solutions

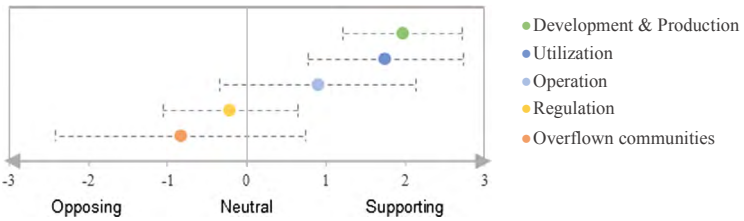


Fig. 3. Positions of stakeholder categories between opposition and support of drone use and their standard deviation, based on the aggregated and averaged data.

As [7] in their paper stated "in order to succeed in the introduction of a new technology, experts believe that the balance between the beneficial usages and the inconvenient issues derived from the emergent technology deployment must lean towards the benefits." According to the supporter opponent analysis (see Fig. 3), overflown communities offer the highest opposition to drone use among the stakeholder groups. This is the case as a larger section of the general public does not have the opportunity to make a trade-off between benefits such as economic gains and their concerns of drone usage. It is therefore very important to openly communicate the potential societal and environmental benefits, be transparent in the data shared, and promote inclusiveness i.e. allow their participation in one way or another. This will further spread awareness about regulations, privacy and data protection laws and build trust. Some concepts are already being explored and implemented in this context: E-identification and registration of drones, app-based identification of in-flight drones and its operation, no-flight zones and operating bans, and data anonymization techniques such as scrambling or masking out the faces of pedestrians/personal information (similar to google earth). Current EU regulations requirements such as 'airworthiness' CE mark certification and operator licensing further aid in mitigating the general public's safety concerns. As a conclusion, proper regulations for citizens in terms of law enforcement, emergency numbers, and legal support is vital for public acceptance and adoption of drones.

4 Outlook

In this paper, the performed stakeholder analysis allowed us to identify actors, combine them into categories, and explore each category's perceived benefits and concerns. The insights gained into the attitude of each stakeholder group towards drone use will support our future work in ADACORSA. As the overflown communities were found to have the lowest benefit-concern ratio, their concerns must be considered for successful adoption of drones. Therefore, our next steps are to focus on public acceptance and develop a drone acceptance model. Both this project and further research in this area will promote acceptance of commercial drones and bring us closer to a drone reality.

Acknowledgments. This paper is part of the ADACORSA project that has received funding within the (ECSEL JU) in collaboration with the H2020 Framework Programme (H2020/2014–2020) and National Authorities, under grant agreement 876019. We thank all experts for their participation in the interviews and workshop and sharing their expert knowledge of the drone industry.

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Google Trends to Investigate the Degree of Global Interest Related to Indoor Location Detection

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Abstract. The scientific contribution of this paper is a Big Data-centric study, conducted using Google Trends, that involved analysis of the global, country-level, and state-level search trends related to indoor localization by mining relevant Google Search data from 2015–2020. There are three novel findings of this study. First, the current global search interest in indoor localization is higher than the average, median, and mode values of search interests (since 2015), and it is projected to keep increasing in the near future. Second, Singapore predominantly leads all other countries in terms of user interests in indoor localization. It is followed by Canada and United States, which are followed by the other countries. Third, the state-level analysis for the United States shows that Massachusetts leads all other states in terms of user interests in indoor localization. It is followed by New Jersey and Michigan, which are followed by the other states.

Keywords: Google trends · Indoor localization · User interests · Big data · Indoor location detection · Google search · Search interest · Search trends

1 Introduction

An important source of information related to human-computer, human-machine, human-robot, or human-technology interaction is embedded in the spatial data. People are familiar with the use of Global Positioning Systems (GPS) and Global Navigation Satellite Systems (GNSS) for outdoor navigation [1]. However, there is no clear way for getting spatial data easily and accurately in applications involving technologies and end-users within the confines of buildings, rooms, or any indoor environment in general [2]. With the advent of Industry 4.0, the future of people's everyday lives would involve interacting, coordinating, and collaborating with computers, machines, robots, and a myriad of technology-based gadgets and devices in multiple ways [2]. As humanity is headed towards such a future, there has been an escalating global demand for indoor location detection related technologies so that the future of technology-based interconnected ubiquitous-computing driven environments – such as Smart Homes and Smart Cities, can create sustainable, equitable, and habitable living experiences in the context

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 580–588, 2022.
https://doi.org/10.1007/978-3-030-85540-6_73

of these multimodal forms of human interactions with technology [3]. Society will foresee a market for indoor localization systems of the order of USD 10 billion or even more by 2024 owing to the diversified use cases for which such technologies are suited [4].

There are several application domains of indoor localization in the future of smart environments [3]. Some of these include – (1) monitoring the position of assets and items during smart production and smart manufacturing; (2) monitoring and locating unmanned vehicles and robots in automated or semi-automated industries; (3) recording and reporting the accurate location of an elderly fall in indoor environments to emergency responders or caregivers; (4) assisting older adults with various degrees of Cognitive Impairment (CI) in conducting their everyday activities by directing them to particular regions in the premises of their living space where these activities are performed; (5) recording the exact position of elderly with Dementia or Alzheimer's when they face freezing of gait (FOG) to call for caregiver help; (6) enabling people with visual impairments to find specific items or entities at both their working and living environments; (7) helping older adults who suffer from delirium in their movement from one location to another for various activities; (8) tracking the position of older adults when they face cramps or any kind of bodily impairments to seek caregiver attention and assistance; (9) automated tracking of recovering patients in smart hospitals so that the costs of in-person surveillance may be avoided; and (10) autonomous monitoring of various types of objects, assets, and entities to understand the underlining user interactions in the future of Internet of Things (IoT)-based environments.

In view of the projected market rise of indoor location detection related technologies and its wide range of applications in the future of smart environments, it is highly important and significant that a Big Data-centric pertinent ontology is developed by mining online search data to study the associated patterns of web behavior, and trends in information seeking and sharing related to indoor location detection.

The use of the Internet, powered by the search engine industry that it supports, is now common across the globe. For instance, Google now processes about 3.5 billion searches per day and about 1.2 trillion searches per year [5]. The analysis of online search data has been of interest to researchers studying web behavior [6, 7]. For instance, the study of web behavior towards a specific technology indicates user interests in that technology [8, 9], which could serve as a good indicator of the market potential – its sales outlook, consumer acceptance, the use and applicability of the technology, as well as the general trends of the topic of interest [9]. The degree of interest of the net citizens towards a technology can carry a great deal of information, which can be used to influence many businesses, political, economic, social, and governmental policy-making decisions. The most popular tool for analyzing web-based behavior based on Google Search data is Google Trends [10]. Google Trends is a website by Google that provides users a means to obtain global web behavior data [10]. Google Trends has two major advantages over traditional surveys – (1) there is no cost involved in studying and surveying the search data, whereas traditional surveys are quite often associated with costs, and (2) conducting surveys regularly on a diverse global user group is very difficult whereas Google Trends considers the global search data from daily search results on Google, that can be studied and analyzed easily [11].

Recent works [3, 12–17] for indoor localization have focused on developing various methodologies and approaches but did not focus on studying web behavior related to indoor localization. Addressing this challenge serves as the main motivation for this work. This paper is organized as follows. Section 2 provides an overview of the associated steps and methodology that we followed for conducting this study. The results and discussion are presented in Sect. 3, followed by a conclusion and scope for future work in Sect. 4.

2 Proposed Work

The study was performed in Google Trends by analyzing the worldwide Google search data related to indoor location detection-related technologies and applications from 2015–2020. Figure 1 shows the Google Trends website and its user interface that allows studying and mining online search trends in a given timeframe. Figure 2 shows the set of keywords that we used for conducting this study.

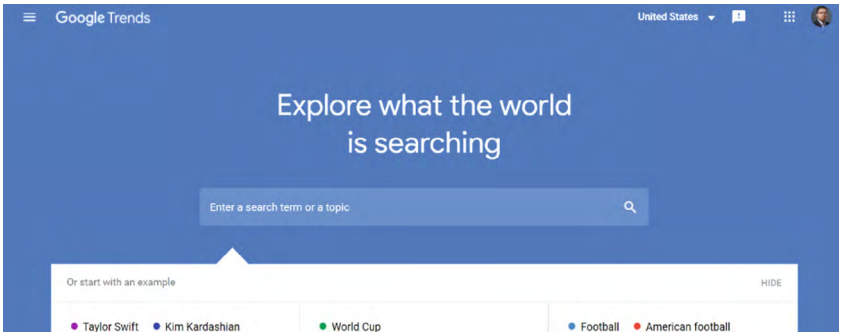


Fig. 1. Screenshot from the Google Trends website where the interface allows entering a search query

As shown in Fig. 3, we performed this study for the past five years (2015 – 2020). For conducting this study, we accessed Google Trends on November 22, 2020, so based on the data collected, we were able to obtain the search trends data in the range of November 29, 2015, to November 22, 2020. For the search trends location – we selected "worldwide" to study the global search data. Then, we selected "all categories" to include all kinds of searches related to the keywords "indoor location", and finally, we narrowed down our search to "web search" to include only the results from google web search and exclude all search results related to google shopping and image searches.

Upon entering these details, we were able to download the search trends-related data as a .csv file on the local computer. This .csv file consisted of two attributes. The first attribute, "Week", consisted of specific days (7 days apart) from 2015–2020. The second attribute, "indoor location: (Worldwide)", consisted of the search interest values corresponding to each of these days recorded based on Google search data. We calculated the average, median, and mode values of search interests by performing mathematical

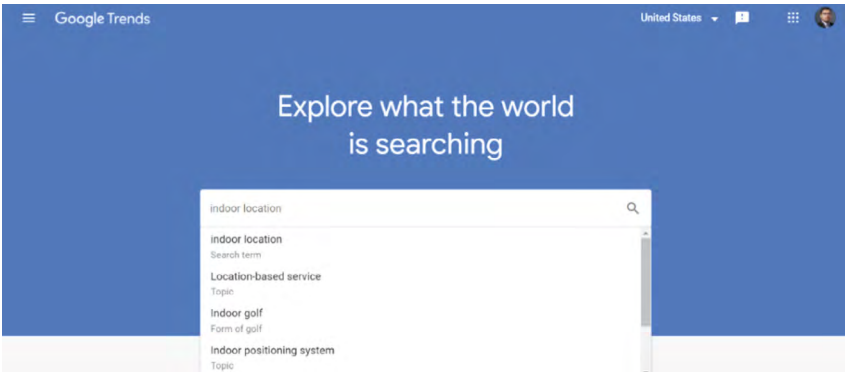


Fig. 2. Screenshot of the Google Trends website where we entered the query – "indoor location"

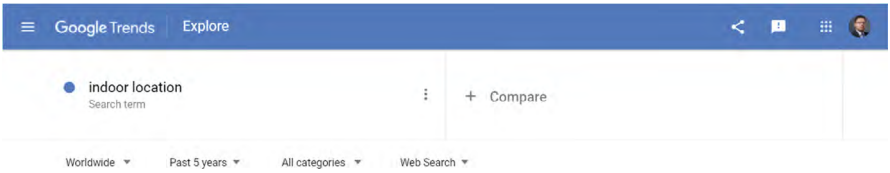


Fig. 3. Screenshot from the Google Trends website showing different search-related features that can be modified or updated as per the need

operations on the data. In addition to providing this web behavior data, the "Interest by region" section on the Google Trends website provided us the raw data to investigate the interests across different countries, where each country was assigned a search interest value based on the number of google searches related to indoor location detection in this timeframe (from 2015). Upon obtaining this country-level search interest data, we analyzed the state-level interests related to indoor location detection-related technologies for all the countries in a similar manner. We repeated the above steps by changing the location from "worldwide" to the name of each of these countries, taking one country name at a time. When we conducted this study at a country level, the "Interest by region" section on the Google Trends website provided us the raw data to investigate the search interests across different states of that country, where each state was assigned a search interest value based on the number of google searches related to indoor location detection in this timeframe. For lack of space, we have discussed and presented the analysis for only one of the countries – the United States, in this paper.

3 Results and Discussions

Using Google Trends [10], we mined the search interests at a global, country, and state-level, as per the methodology outlined in Sect. 2 associated with the keywords – "indoor location". This phrase was chosen because it encompasses and represents a wide array of popular Google Searches related to indoor localization, as obtained from Google Search

data. These searches include "indoor location detection", "indoor location tracking", "indoor location technologies", "indoor location and navigation", "indoor location-based services", "indoor location service", "indoor location solutions", "indoor location market", "indoor location software", "indoor location applications", "indoor location and wayfinding", "indoor location system", and "indoor location sensing". This study analyzed the search interests related to these keywords based on Google Search results from 2015–2020. The search interest value for a set of keywords for a specific date is computed by Google Trends by analyzing all search results on Google related to those keywords on that specific day. Here a value of 100 represents peak interest, and 0 represents very minimal interest. The earliest date in 2015 for which we were able to obtain a search interest value was November 29, 2015, and the most recent date in 2020 for which we were able to obtain a search interest value was November 22, 2020, with the associated search interest values being 64 and 57 respectively. The data mining process provided us the search interest values at an interval of 7 days starting from November 29, 2015, and ending on November 22, 2020. The data had 261 rows. The search interest values for the last four days – November 1, November 8, November 15, and November 22, were 31, 35, 38, 57, respectively. The average, median, and mode of all the search interest values were found to be 53.50, 53, and 46, respectively. The highest search interest value, 100, was recorded on December 31, 2017, and the lowest search interest value, 17, was recorded on April 5, 2020.

We further studied this data by analyzing the varying search interests with the average, mode, and median values of the search interests for all the days for which search interest values were mined. This analysis is presented in Fig. 4, where the Y-axis represents the weekly search interest, the average search interest, the mode value of the search interests, and the median value of the search interest represented by different colors. This study was performed in RapidMiner [18] by using its built-in visualize function that allows analysis and interpretation of trends and patterns in Big Data.

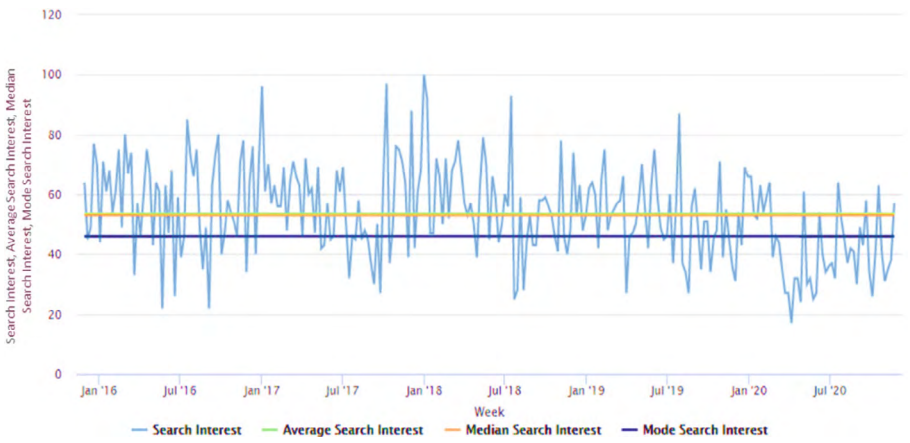


Fig. 4. Analysis of the global search interest data recorded on different days from 2015–2020 by comparing it with the average search interest, median search interest, and mode search interest values

From Fig. 4, it can be seen that the most recent search interest value, 57, is higher than the average, median, and mode values of search interests recorded over the years, as well as it is higher than the recent search trends data indicating increased worldwide interests for indoor location detection related technologies and applications. The constantly increasing trend, as can be seen from the recent data points corresponding to November 1, November 8, November 15, and November 22, also indicates that the worldwide interests related to indoor location detection will further increase in the near future by following the same upward trend. After that, we analyzed the country-level interests related to indoor location detection from 2015–2020. The search interest data from all the countries of the world were mined, studied, and analyzed. Google Trends did not assign a search interest value to those countries where the search interest had been consistently minimal during this time frame. Thus, the countries that were assigned search interest values by Google Trends were Singapore, Canada, United States, Malaysia, Australia, United Kingdom, Philippines, France, India, Germany, and Brazil.

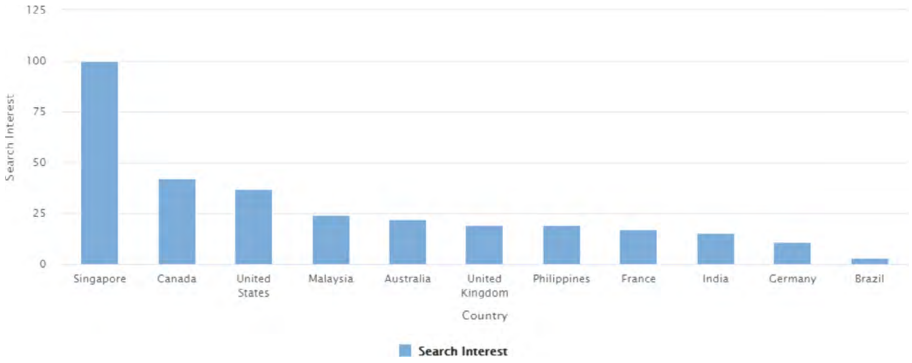


Fig. 5. Analysis of the search interests related to indoor localization studied at a country level from 2015–2020. Those countries that had a consistently minimal search interest are not shown.

Figure 5 shows the results of our study, where we analyzed the country-level search interests related to indoor location detection from 2015–2020. Those countries where the search interests were consistently very low were not included in this study. As shown in Fig. 5, with a search interest value of 100, Singapore predominantly leads all other countries globally in terms of search interests related to indoor location detection-related technologies and applications. It is followed by Canada and United States, with the search interest values being 42 and 37, respectively. The United States is followed by Malaysia, Australia, United Kingdom, Philippines, France, India, Germany, and Brazil, in decreasing order of search interests. The respective user interest values of these countries were 24, 22, 19, 19, 17, 15, 11, and 3. After that, we analyzed the state-level search interests for each of these countries. Due to the paucity of space, we present the findings of our study only for the United States here . We mined the search interest values related to

"indoor location" for each state in the United States in this timeframe. Again, these data were analyzed in the RapidMiner tool. Those states where a consistently low search interest value was recorded were not included in this study. The results are shown in Fig. 6.

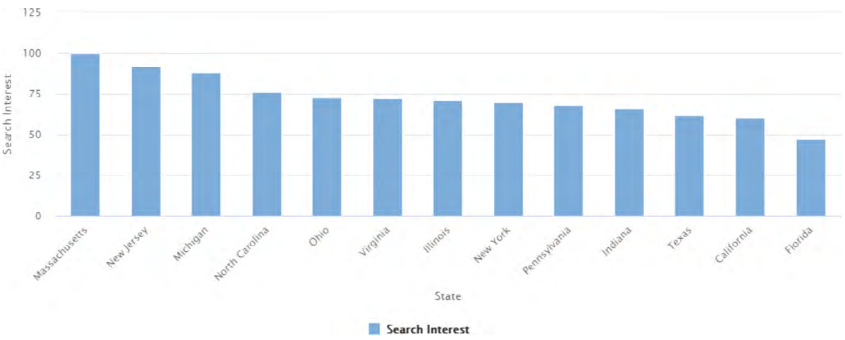


Fig. 6. Analysis of the search interests related to indoor location studied at a state level for the United States from 2015–2020. Those states that had a consistently minimal search interest are not shown.

From Fig. 6, it can be seen that out of all the states in the United States, Massachusetts recorded the highest search interest value of 100 in this timeframe, i.e., from 2015–2020. It was closely followed by New Jersey and Michigan, with their respective search interest values being 92 and 88. Following Michigan, the other states arranged in order of decreasing search interests were North Carolina, Ohio, Virginia, Illinois, New York, Pennsylvania, Indiana, Texas, California, and Florida. Their respective search interest values were 76, 73, 72, 71, 70, 68, 66, 62, 60, and 47.

4 Conclusion and Future Work

The work presented in this paper shows how the study of global web behavior related to a specific technology indicates diversified patterns of user interests towards that technology in different regions of the world. Our particular interest was on indoor localization in view of its potential applications in the future of smart environments – such as Smart Homes and Smart Cities. We conducted a study using Google Trends to mine the relevant Google Search data related to indoor localization from 2015–2020. The study analyzed and interpreted the associated user interests at a global, country, and state-level. The findings of this study are three-fold. First, the most recent global search interest value is higher than the average, median, and mode values of search interests recorded over the years (since 2015), and its increasing trend indicates that the global search interests related to indoor location detection are going to continue increasing in the near future. Second, the country-level study where each country was assigned a search interest value, based on all the relevant searches from all the countries since 2015, shows that Singapore predominantly leads all other countries globally in terms of user interests related to indoor location detection-related technologies and applications. It is followed by Canada and

United States, which are followed by the other countries. Third, the state-level analysis for the United States, where each state was assigned a search interest value, based on all the relevant searches from all the states since 2015, shows that Massachusetts leads all other states in the United States in terms of user interests related to indoor localization. It is closely followed by New Jersey and Michigan, which are followed by the other states. As per the authors' best knowledge, no similar work has been done in this field yet. Future work would involve investigating factors and discussing possible reasons behind some countries and their respective states registering very low search interests to address the same.

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Production Management Model Based on Lean Manufacturing and SLP to Increase Efficiency in the Tapestry Manufacturing Process in Lima Manufacturing SMEs

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Abstract. Currently SMEs present many challenges such as competition with local markets, inefficiency in productivity, quality and services, representing a financial imbalance. In Peru, one of the main problems for SMEs is the lack of planned production and a poor distribution of work. These problems faced by all SMEs generate that entrepreneurs seek different ways to overcome the problems mentioned above applying different solutions to generate opportunities, providing greater productivity and establishing sustainability in companies. This article presents a case study in a small upholstery company that presents production efficiency problems where a production management model based on Lean Manufacturing and SLP will be implemented to achieve that capacity improves, productivity increases eliminating waste while minimizing waste. costs and activities within production in order to increase the flow of material rotation, managing to meet customer orders on time, both in the manufacturing and service industries.

Keywords: Efficiency · Lean Manufacturing · SLP · SMEs · 5S

1 Introduction

SMEs are considered to be companies that employ a minimum number of 11 workers up to a maximum of 250 workers with an annual turnover of less than 1,700 UIT, according to INEI [1]. SMEs, according to the UN, generate between 60% and 70% of employment worldwide and are considered the backbone of the economy and employers worldwide [2]. Likewise, SMEs in the Peruvian business sphere play a fundamental role since they are the main producers of employment, according to the Ministry of Production [3]. Also, according to SUNAT, it is known that SMEs have a high participation in the productive sectors, representing 46.24% and 41.32% respectively [4]. For example, according to Kevin Kelly, he reports that used car sales grew 87% in the last 10 years and has been

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 589–596, 2022.
https://doi.org/10.1007/978-3-030-85540-6_74

increasing steadily 8% since 2007 [5]. According to, this information highlights the primary role in the dynamics of the Peruvian market that SMEs play [6].

In Peru, SMEs represent a very important stratum in the country's productive structure, both due to the number of establishments and the generation of employment. It is calculated that SMEs contribute only 23.5% of the total added value generated by private companies, according to the Ministry of Production [7]. Compared with data from the National Bureau of Statistics of China, foreign SMEs represent 99.4% of all companies according to Villavicencio Morejón, Ajila Rodas and Tutiven Campos Wang [8]. The importance of improving this problem lies in the development of the economy of an SME and therefore in the national economy due to the large market they represent.

The motivation of the article is based on the challenges faced by manufacturing SMEs. The contribution of this article consists of adapting a production management model based on the methodology called "Impact of existing lean production" to the context of these SMEs. The contribution methodology is characterized by using Lean Manufacturing tools with the systematic design planning (SLP) method. According to Goshime, Kitaw and Jilcha (2019), Lean Manufacturing is a technique with the ability to improve productivity [9]. Likewise, according to Suhardi, Juwita, & Astuti, the systematic design planning method (SLP) is understood as a planning process that allows identifying, visualizing and evaluating activity relationships [10].

2 State of Art

2.1 Production Management Based on Lean Manufacturing in SMEs

The implementation of Lean Manufacturing tools in small and medium-sized companies have been considered necessary and vital so that an organization over time can survive in the face of different adversities, improving its productivity and customer satisfaction. Given this situation, there is a need to develop a methodology that helps manufacturing SMEs to adopt lean tools to significantly improve their operational performance and customer satisfaction [11, 12].

A Lean model tools guides company representatives to make informed decisions regarding the adaptation of tools to become more efficient in labor-intensive production [11, 13]. The use of these tools leads to eliminating or minimizing waste or activities that do not add added value when producing or offering services, generating distinctive internal capacities for the survival and growth of small and medium-sized enterprises [14–16]. An SME can improve its lean practices increasingly by considering success factors in its production management such as the learning approach, improvement training, top management support, a shared vision and a link with the supplier [12, 13].

2.2 Production Management Model Based on Lean Manufacturing and SLP in SMEs

Adapting Lean Manufacturing and the systematic design planning (SLP) method in an organization helps to improve with time, as well as control of its processes by reducing operations and activities that do not generate value. In addition, combining these two

methodologies and using them within the manufacturing sector saves transfer times, which can be invested in the manufacture of more products, improving the use of plant capacity. This allows to improve the problem of unfulfilled orders, achieving greater customer satisfaction [17, 18]. The Lean concept is one of the methods that is widely implemented to reduce the appearance of defective products and waste that do not provide added value that combined with the design of the layout of the facility allows to reorganize the areas of the production process so that the distance between processes can be minimized. SMEs benefit as improving these points allows providing quality products and better standardization of the workplace [3, 4].

3 Input

3.1 General Contribution

The main idea of the contribution is to achieve the highest levels of productivity, effectiveness and operational efficiency through Lean Manufacturing implementation complemented with Systematic Design Planning (SLP) (See Fig. 1). This is achieved by developing the following stages. First, a planning and execution of Activities is done. Afterwards, the improvement proposal is presented. Then the Proposal for improvement is implemented. Finally, the improvement is evaluated through the use of indicators.

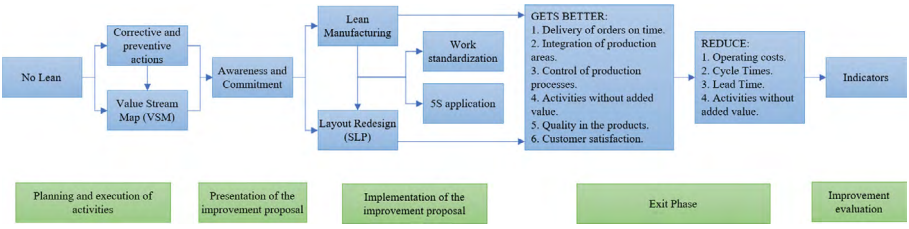


Fig. 1. Production management model based on lean manufacturing and SLP Source: Goshime, Kitaw and Jilcha (2019)

3.2 Detail Contribution

Planning of Execution of Activities. The model begins with the first component called activity execution planning, which shows the situation of the company that is not efficiently productive or competitive and that its manufacturing practice does not have a lean concept. To do this, the current situation of the company is shown and ABC is used in order to identify the most representative product that generates greater sales and profits for the company to focus efforts on improving the process and its operations. Likewise, the Value Stream Mapping (VSM) tool is used to graphically capture the process and thus identify waste in production. Followed by this, takt time is used whose approach is to demonstrate the impact by recording the cycle time of each station to identify bottlenecks in the production process. After this, the improvement objectives are set with the tools to be used and it is graphically reflected using the future VSM. Finally, the waste identified and presented in the future state, the control indicators are defined.

Presentation and Acceptance of the Improvement Proposal. The second component of the proposed model is the presentation and acceptance of the improvement proposal. For this, three main activities are identified. The first activity consists of preparing the request for the meeting to present the improvement project, which consists of a format that mainly defines the date, the start time, the people involved and the place to successfully hold the meeting. The second important activity is the development of the presentation, the compilation and preparation of the formats to be delivered at said meeting as a possible schedule, stakeholders, current and future VSM, indicators, managers, etc.

Finally, it concludes with the project presentation activity in which the structure of the topics to be carried out on the day of the meeting is defined, in other words, the day's schedule.

Implementation of Improvement. The improvement implementation phase consists of developing lean manufacturing in the company using the different Lean Manufacturing and Systematic Layout Planning tools to reduce waste such as cycle time, delivery time, in-process inventories and product manufacturing costs. In other words, it employs the use of job standardization, the 5S and Layout redesign.

Evaluation of Improvement. The last component of the proposed model is the improvement evaluation that points out the positive of changing non-lean practices to lean and implementing SLP for the layout redesign. That is, in this phase the impact on the productivity of the company that falls on customer satisfaction is shown. To do this, those responsible for the improvement control and the indicators are defined.

4 Indicators

Efficiency

$$EFICIENCIA = \frac{Producción;\ real}{Capacidad\ instalada} * 100\% \tag{1}$$

Hours of Operation

$$Horas\,de\,operación = \sum_{i=1} horas \tag{2}$$

Reprocessed Products

$$\%PR = \frac{Total\ de\ productos\ reprocesados\ al\ mes}{Total\ de\ productos\ procesados\ al\ mes} * 100 \tag{3}$$

Orders Delivered on Time

$$\%P.E.A = \frac{Pedidos\ entregados\ a\ tiempo}{Pedidos\ solicitados} * 100 \tag{4}$$

5 Validation

5.1 Case Study: General Data of the Company

The company Tapicería Automotriz is a SME company in Lima dedicated to the manufacture and production of leather upholstery. Likewise, its main facilities are the marking, sewing, installation or assembly and warehouse area. Here are other details of the company:

- Working hours: 10 h/day
- 1 shift per day
- Days a week: 6 days
- Days per month: 23 days
- Monthly demand for seat mat: 56 units/month.

5.2 Initial Diagnosis

For the initial diagnosis, an analysis was carried out based on information provided by the company. According to Cabrera, Galetovic and Sanhueza explain to us that the efficiency of SMEs abroad presents a production efficiency of 70% [19]. The current efficiency of the case study is below those established with 43.30%. Demonstrating that the company has an inefficiency in the production of upholstery.

5.3 Execution

The main cause related to the main problem is the line imbalance with 76.00% followed by the delay in material requirements with 16.00% and finally with the reprocessed products with 8.00%.

5.4 Validation Method

The validation method includes an operational evaluation using the ARENA software and an economic validation.

Model validation in Arena. The simulator developed has the objective of representing the process in production considering the resources, stations and data that are detailed below.

- Number of operators: 7
- Working hours: 10 h/day
- 3 stations (marking, sewing and installation)
- Maximum sewing time: 9.86 h (takt time)
- Percentage of rework in sewing: 22.1%
- Material stockout rate: 7%

The simulation variables to be considered in the output data were: total products manufactured, sewing time, number of reprocesses, number of out-of-stock orders, sewing queue size, and system time.

Scenario 1: Current Situation of the Company. Scenario 1 shows the analysis of the current situation based on the diagnosis present in the upholstery SME. This scenario will be compared with the proposed scenarios to analyze the impact of the

Scenario 2: Current Situation of the Company. Scenario 2 as the proposed proposal is to eliminate the delay in the requirement of materials or, in other words, eliminate 7% of the out-of-supply orders. Likewise, in this same scenario, it is proposed to reduce and/or eliminate the amount of reprocessed products that represent 22.1% of production.

Scenario 3: Current Situation of the Company. Scenario 3 that arises consists of reducing the time of the sewing area that currently represents the bottleneck in production. To do this, it is proposed to make use of the SLP to reduce the flow of materials and use the standardization sheets indicating the work time for each activity.

Scenario 4: Current Situation of the Company. The fourth proposed scenario involves both the elimination of the bottleneck and the elimination of material delays and order reprocessing in order to considerably increase production and therefore efficiency, making better use of resources.

Table 1 shows that scenario 4 represents the best option, since it increases efficiency by 55.7% from what was initially 34.4%.

Table 1. Result of the efficiency evaluation

Situation	As is (current)	Desired indicator	To be (results obtained)		
Scenarios	1: current	Diagnosis	2: 5s with just in time	3: SLP with standardization	4: implement the 4 tools
Cant of stopped orders	1.506	0	0	1.5261	0
Cant reprocessed	3.016	1.8	0.27711	4.6144	0.36948
Tam queue sewing	2.1323	–	0.95364	0.239	0.00304
T sewing	15.637	9.86	12.377	7.6261	5.6351
Total products manufactured	10.413	15.5	13.341	15.273	16.546
T system	21.964	–	18.474	14.347	11.826
Efficiency	34.4%	60%	40.25%	46.44%	55.73%
Investment cost	S/. 0.00	–	S/. 2,790.00	S/. 3,000.00	S/. 5,790.00

5.5 Economic Evaluation

For the economic evaluation, the viability of this improvement project was measured, considering the cost reductions caused by the main problem of the case study.

Project Cash Flow. Cash flow was evaluated over a 12-month time frame, with a discount rate of 15% and a tax rate of 29.5%. Taking into account these premises, the following results were obtained:

- VAN'S/. 42,606.85
- IRR: 51%

As can be seen in the calculations, the NPV > 0 and IRR > Annual Discount Rate being the project profitable.

6 Conclusions

The Lean methodology complemented with the Sistematic Layout Planning (SLP) tool allowed to identify the activities and operations that do not generate value, as well as the flow of materials that currently has a route of 63.02 m. Faced with this situation, the redesign of the facilities was proposed using qualitative and quantitative tools consisting of the Relational Activity Diagram, thus obtaining a new Layout. Likewise, using the quantitative tool that is the effort matrix, it was identified that the new distribution of the areas would improve productivity by 34.56%. Finally, analyzing the improvement proposal, it was identified that a reduction of the material flow path is achieved to 44.15 m.

The implementation of the standardization of work, redesign of Layout and the 5s would achieve an increase in production efficiency from 10 units per week to 16 units per week on average according to the validation with the ARENA tool. In other words, it would show an efficiency improvement from 34.4% to 55.7%.

Currently, the making of the seat upholstery in the sewing area represents a bottleneck for production, the cycle time being 11.4 h/unit When using the work standardization tool with the use of a process manual a decrease in the time in the manufacture of the seat uphol stery would be achieved to 7 h/unit showing a reduction in time by 4 h/unit.

The improvement proposal implemented in the upholstery company has the main objective of increasing the efficiency in the production of upholstery in a SME, allowing them to be competitive in the market. Furthermore, this proposal helps with the challenges faced by SMEs, such as inefficiency in planned production and a poor distribution of the work area.

Regarding the final results of the economic impact, it can be concluded that the application of the improvement proposal made up of the Lean tools, such as work standardization, the 5's and the redesign of the Layout is viable, since it can be observed a profitability 51% positive IRR with an additional gain of S/.42,600.

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Can the Inter Planetary File System Become an Alternative to Centralized Architectures?

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Abstract. The Inter Planetary File System is a decentralized storage network based on peer-to-peer communication and strives to become an alternative to centralized standards such as HTTP. However, there is a pressing need in analyzing the performance of the former compared to the latter. Therefore, this paper deploys a testbed scenario to compare physical resources' usage and transmission delay between IPFS, IPFS Cluster and threaded and non-threaded HTTP. Results show that although HTTP currently delivers higher throughput, its centralized approach can overwhelm servers and IPFS can leverage its decentralized architecture mostly for large-scale scenarios. Moreover, results also empirically show that IPFS' content addressing resolution poses a serious challenge and should be addressed by its developers.

Keywords: Decentralization · Inter Planetary File System · Decentralized storage

1 Introduction

The Inter-Planetary File System [1, 2], or IPFS, was created in 2015 as an effort to overcome an issue intrinsic to traditional storage solutions: centralization. To achieve its goal, IPFS builds a network of nodes sharing data spanned across them in a decentralized fashion. Overall, a specific file, namely content or object, is divided into small portions of data limited to 256 KB locally stored in participating nodes. An object's content is used to generate a hash that uniquely identifies itself, namely Content Identifier (CID), and such object shall be retrieved by its specific CID. Note that this approach is built on the fundamentals of peer-to-peer networking [3] and content-based addressing since data storage is not centralized and data retrieval is associated with its content, not its location.

Although IPFS has been proposed as an alternative to centralized architectures in general, its actual focus has been to overcome the limitations of the HTTP protocol specifically [4]. HTTP is a client-server architecture protocol where endpoints communicate by establishing a path between the known locations of these endpoints. Therefore, this location-based communication characterizes a centralized infrastructure. Centralization

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 597–604, 2022.
https://doi.org/10.1007/978-3-030-85540-6_75

has been the core architecture for most Internet (and TCP/IP in general) protocols. However, disruptive events such as attacks, natural disasters, man-made disasters, hardware failures or outages, may result in data and services unavailability for storage or devices located within the range of failure. Furthermore, although the deployment of distributed resources is possible, the number of nodes participating in the cluster is limited and the content remains location-oriented.

Now, taking in consideration that the IPFS' decentralized architecture delivers a higher degree of availability compared to location-based protocols since data is stored in a virtually unlimited number of different nodes, this study focuses on analyzing how IPFS implements data decentralization and how performable it is compared to HTTP. Specifically, we have deployed a scenario comprised of 5 virtual machines geographically distant, and yet within the US territory, and ran different tests in order to: a) understand IPFS' object addressing and replication, b) compare physical resources' (RAM, CPU and I/O) performance between IPFS and HTTP in a 2-node topology transmitting small files, c) compare physical resources' (RAM and CPU and I/O) performance between IPFS and HTTP in a 5-node topology transmitting small files, d) compare physical resources' (RAM and CPU and I/O) performance between IPFS and HTTP in a 2-node topology transmitting large files, e) compare physical resources' (RAM and CPU and I/O) performance between IPFS and HTTP in a 5-node topology transmitting large files.

This study shows that although the IPFS network deploys decentralization, remote data storage and dissemination is not natively implemented. Once new content is added to the IPFS network, it is only locally stored by the participant node that added it. Once additional peers retrieve a specific content, these also store it locally and start sharing for a short period of time, unless pinned. Thus, implementing an additional software called IPFS Cluster may be necessary to overcome this issue. Finally, results also show that RAM and CPU usage along with I/O operations can be much less cost-effective than the HTTP protocol for large files when the transmission occurs between 2 nodes. On the other hand, as more clients start to open simultaneous connections with the HTTP server, the latter's performance can degrade whereas the simultaneous communication among IPFS nodes remain stable on a server-side perspective. Therefore, in order to present our findings, this paper is organized as follows: Sect. 2 summarizes a few studies on IPFS, sequentially Sect. 3 covers the proposed testbed describing the scenario/topology along with the specific tests. Furthermore, results are presented in Sect. 4, followed by our conclusion in Sect. 5.

2 Related Work

In 2015, Protocol Labs launched the alpha version of IPFS, which shows that the IPFS solution is very recent, and therefore, not many studies on it have been deployed. Here, we try to summarize a few relevant efforts that strive to map and analyze IPFS, and describe why this proposed study differentiate from these others. Note that studies deploying IPFS as an enabler are out of our scope.

In 2019, Shen et al. [5] deployed a comprehensive analysis of the IPFS I/O performance in a client's perspective. The authors created a testbed using Amazon EC2 instances and ran several tests to show how content-addressing resolution can become a bottleneck in such networks, showcasing challenges for IPFS. However, the adoption of a client's perspective can limit our capacity to compare IPFS with current centralized TCP/IP storage and sharing standards such as HTTP.

Moreover, Cristea et al. [4] introduced an Android framework to guarantee higher data availability using IPFS storage. Although IPFS was here deployed as an enabler and no performance analysis was conducted, the authors described the IPFS solution, not only the IPFS routing implementation. This effort compared IPFS with other centralized storage solutions, such as HTTP, NFS, GFS and AFS, corroborating the advantages of deploying decentralized storage.

Finally, Henningsen et al. [2] deployed a testbed to comprehensively map IPFS. The authors theoretically and technically detail the IPFS' layers and protocols. Although Cristea et al. [4] initiated this study, they did not perform and extensive and neither technical analysis of IPFS.

In summary, although some important work have been deployed in order to analyze the advantages and disadvantages of IPFS, and to stimulate its adoption, a more comprehensive analysis of its performance compared with other current centralized applications is critical.

3 Testbed

As note in Sect. 1, this study is conducted by deploying a scenario testbed to run 4 different tests: a) compare physical resources' (RAM, CPU and I/O) performance between IPFS and HTTP in a 2-node topology transmitting small files, b) compare physical resources' (RAM and CPU and I/O) performance between IPFS and HTTP in a 5-node topology transmitting small files, c) compare physical resources' (RAM and CPU and I/O) performance between IPFS and HTTP in a 2-node topology transmitting large files, e) compare physical resources' (RAM and CPU and I/O) performance between IPFS and HTTP in a 5-node topology transmitting large files.

Thus, the testbed is composed of 5 Linux CentOS virtual machines in the cloud located geographically distributed across the United States. Specifically, their locations are Atlanta (ATL), Chicago (CHI), Dallas (DAL), Los Angeles (LA) and Seattle (SEA). Each and all virtual machines have the same configuration: 2-core 3.5 GHz CPU, 2 GB RAM, 40 GB SSD.

For the 2-node tests (a and c), the Atlanta and Los Angeles VMs are profiled as the content provider (server) and content requester (client), respectively. For the other tests (b and d), Chicago, Dallas and Seattle participate in the IPFS cluster (cluster nodes), acting as content storage nodes. The tests are detailed in the following subsections.

3.1 2-node and 5-node Small Files Testbeds (A and B)

In these 2 scenarios, 900 files of approximately 256 KB are transmitted between LA (client) and ATL (server) per iteration, out of a total of 10 iterations (a 30-s interval per iteration is set as well). The first 10 iterations are done using the a*ria2c* tool, which allows us to simulate a browser, that by default open 6 simultaneous connections with the server. Then, 10 other iterations are deployed using the *wget* tool is used, which establishes a unique connection between source and destination. Both tools implement the HTTP protocol, therefore, alternatively 10 other iterations are put in place using the IPFS-GO for IPFS transmission. First, only ATL stores the content to be fetched by LA, which guarantees that content transmission is occurring between these two endpoints only. Then, CHI, DAL and SEA are added to the IPFS network and a 4-node IPFS storage cluster is created to share content (ATL, CHI, DAL and SEA). The goal of the latter is to determine whether an IPFS Cluster can improve performance.

3.2 2-node and 5-node Large Files Testbeds (C and D)

As mentioned in Sect. 1, IPFS uses the same concept deployed by peer-to-peer networks, such as torrent. Therefore, an object is segmented into small blocks of data limited to 256 KB. This means that the transmission of objects composed of several blocks requires content-addressing of each of those blocks, since each block will carry its own block/content identification (CID). Moreover, the goal of transmitting larger files, namely content A with 125 MB and content B with 335 MB, is to analyze how consistent and persistent content address resolution tasks can impact the IPFS performance compared with HTTP transmissions. This dense transmission is also performed using *aria2c*, *wget*, IPFS-GO and IPFS-GO in a cluster, similarly to testbeds in Subsect. 3.1.

4 Results

4.1 2-node and 5-node Small Files Testbeds (A and B)

The difference between the 2-node and the 5-node testbeds consists of the absence or presence of IPFS Cluster. Specifically, in the 2-node testbed, ATL is forcibly the hosting node whereas in the 5-node testbed ATL, CHI, DAL and SEA are providing all contents. Thus, take in consideration that resources are measured in HTTP and IPFS content provider (server). This means that no additional usage is expected to be seen in ATL for a 5-node testbed. Nevertheless, the transmission time shall illustrate the performance differences between a clustered IPFS network and other implementations. Additionally, the small files testbeds differ from the large files testbeds in regards to file sizes. Although it may seem like file sizes (or content length) should not impact performance, we must consider how IPFS is structured. It is critical to consider that IPFS implements P2P communication, therefore content is divided in blocks of up to 256 KB. As a result, a plural number of content address resolution is deployed, which does not occur in HTTP deployments.

In summary, the averaged (10 iterations) transmission times were: *aria2c* - 14,080 ms; *wget* - 98,823 ms; IPFS outside the cluster 76,859 ms; and IPFS cluster 49,590 ms. Clearly, the *aria2c* concurrent HTTP implementation delivered the lowest transmission rate, which was ~3.5 times faster than IPFS cluster, ~5.45 faster than IPFS and ~7 times faster than *wget*. Now, it is very important to observe here that *aria2c* was faster than IPFS and IPFS cluster due to its concurrency feature analogous to a browser implementation. If we are to compare IPFS with pure HTTP transmission, we can observe IPFS and IPFS cluster performing ~1.3 and ~2 times faster than *wget*, respectively.

Moreover, resources' usage was also assessed for performance measurement. To properly interpret the following graphs, some considerations must be made: a) For small files transmission, *iria2c* initiated at 7:15 and lasted ~7 min, *wget* initiated at 7:23 and lasted ~21 min, and IPFS was initiated at 7:45 lasting ~16. IPFS cluster is not considered for hardware resources consumption since the content was acquired from another sharing node.

First, we analyzed CPU usage, as illustrated in Fig. 1. Although a pair of spikes can be seen for *aria2c* (7:15 mark) and IPFS (7:45 mark), their similarities show that IPFS and HTTP perform similarly. On the other hand, Fig. 2 shows that *aria2c* has a high number of read operations per second (31 ops/s) at its initial client connection request and read operations are constant during that transmission at lower values. Meanwhile, *wget* kept a constant considerably low number of disk read operations and IPFS presented a behavior similar and yet proportionally lower than *aria2c*. These results show that simultaneous connections deployed by browsers leverage a high IO throughput.

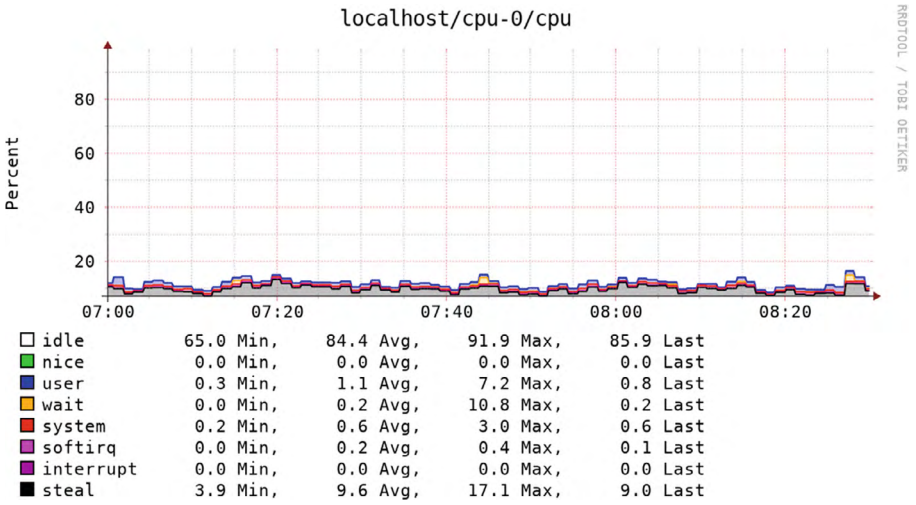


Fig. 1. CPU load for 2-node small files testbed.

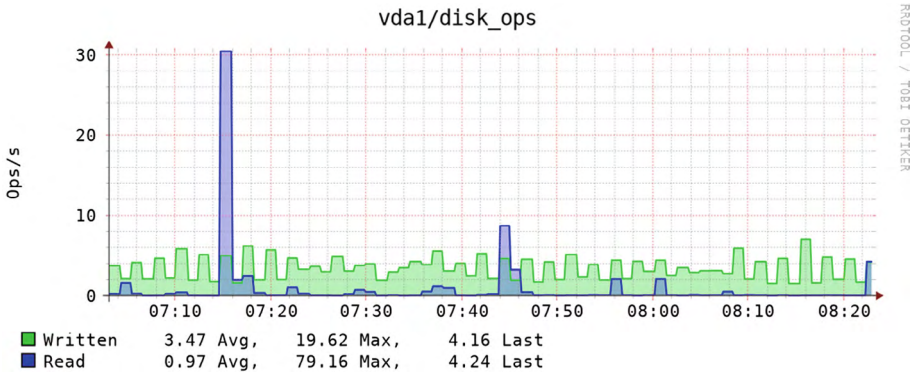


Fig. 2. Disk I/O for 2-node small files testbed.

Now, Fig. 3 presents interesting results. Clearly, *aria2c* delivers higher traffic throughput allowing higher transmission rate, as expected. However, observe that although *wget* was expected to introduce lower throughput, resulting in longer transmission time, it actually presented higher throughput (7:23–7:44 time frame) compared to IPFS (7:45–8:01 time frame). This shows that the HTTP overhead can be overwhelmingly higher than IPFS.

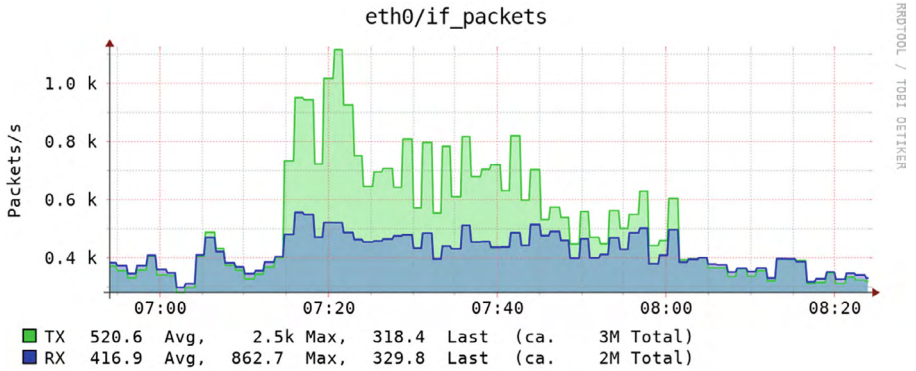


Fig. 3. Traffic rate for 2-node small files testbed.

4.2 2-node and 5-node Large Files Testbeds (A and B)

As previously noted, large files transmission in IPFS networks may require a plural number of address content resolution, resulting in transmission delay. The following results are used to compare HTTP (using *aria2c* and *wget*) with IPFS in regards to their performance difference. Initially, we shall observe the transmission time of 2 large files (file1 125 MB and file2 335 MB) for all four methods: *iria2c* initiated at 12:36 and lasted ~7 min, *wget* initiated at 12:43 lasting almost 8 min, IPFS was initiated at 12:51

and lasted ~14 min and IPFS Cluster started at 13:05 lasting approximately 12.5 min. Thus, *aria2c* performed 1.15 times faster than *wget*, twice faster than IPFS and 1.8 times faster than IPFS Cluster. Now, more importantly, we must compare wget with both IPFS methods. Note that contrarily to the small files testbeds, here pure HTTP transmission delivers better performance in regards to transmission rate since *wget* is 1.75 times and 1.5 times faster than IPFS and IPFS Cluster, respectively.

Figures 4, 5 and 6 demonstrate similar physical resources consumption compared to the small files testbeds. Moreover, this empirical approach demonstrates how the implementation of content addressing resolution for various blocks of data can determine a transmission performance. Whereas for small chunks of data, IPFS performed better compared to pure HTTP (*wget*), here we observe the opposite result for large files.

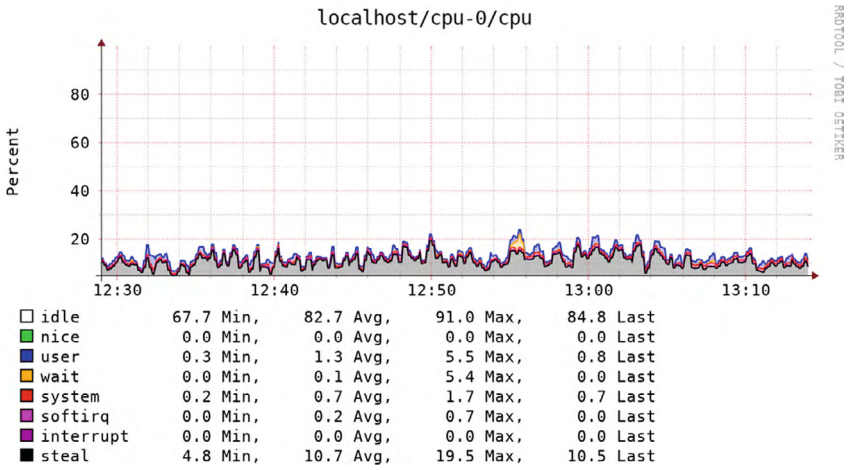


Fig. 4. CPU load for 2-node large files testbed.

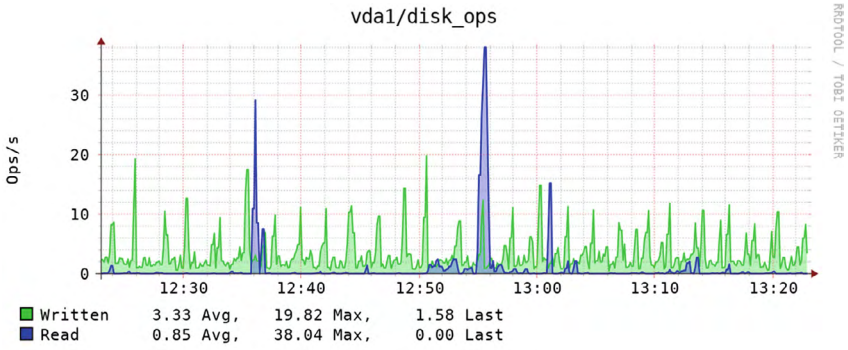


Fig. 5. Disk I/O for 2-node large files testbed.

Now, we must also observe that according to the increasing number of clients, HTTP servers can be overwhelmed due to its centralized characteristics (note Figs. 4, 5 and 6 at the 12:36 mark). On the other hand, IPFS and mostly IPFS Cluster can dissipate such overload by decentralization. In other words, IPFS and IPFS Cluster can indeed become a de-facto public storage solution especially for large-scale deployments.

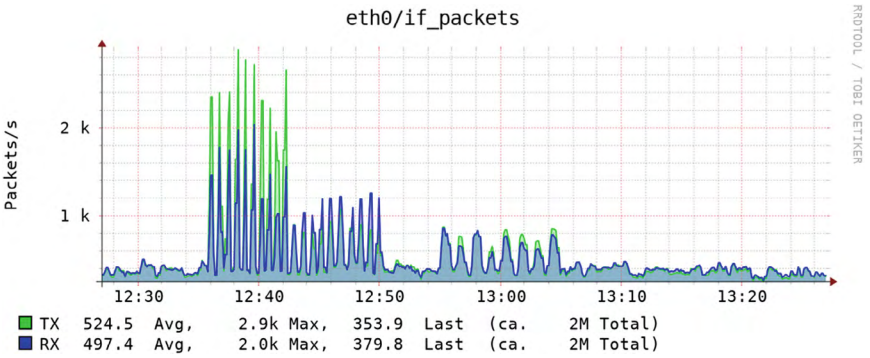


Fig. 6. Traffic rate for 2-node large files testbed.

5 Conclusion

This study shows that although IPFS is a recent solution, its decentralized architecture poses an interesting alternative to location-based protocols, such as HTTP. However, being such a new suite of protocols, IPFS has some limitations and challenges that must be addressed in order to stimulate its adoption. First, allowing IPFS participant clients to implement IPFS Cluster as an option during the installation process would increase data reliability and availability. Also, revising objects segmentation could improve I/O performance by reducing content-addressing resolution. Furthermore, for large-scale deployments centralized solutions such as HTTP can overwhelm servers/participants, whereas IPFS and more specifically IPFS Cluster can leverage its decentralized architecture.

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Can Artificial Intelligence Be Held Responsible?

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Abstract. The article deals with the problem of responsibility or accountability of artificial intelligence built into the vehicle. Researchers introduce the problem of algorithmization of the society and some thought of the prominent persons on the artificial intelligence implementation into day-by-day life. From this background the article focuses on the problems of cooperative autonomous vehicles, their grouping and the behavior of the group in dynamically changed environment. The engineering, sociological and psychological view are compared. Following conclusions are based on the Strawsonian account distinguish between strong and weak AI and argue the power of these AI groups, pointing out reasonable responsibility gap. The article is closed by conclusion on responsibility or accountability of AI in autonomous vehicles at current state of art.

Keywords: Responsibility · Accountability · Autonomous vehicles · Cooperative systems · Moral responsibility

1 Introduction

The society is being algorithmized. The trends in the society to replace any possible functionality by computer, leads to the algorithmization of the society, limiting the variety of a human responses to the Yes or No. Based on this background, "Yes/no" generation is growing up. After short decline of development in the artificial intelligence (AI) area in seventies of the last century, large corporation rose the flag of the AI again, but as a marketing tool not as a scientific problem. Nevertheless, the development in the AI is continuing even while any interacting application is named as AI product, thus diverting the attention of the society from the real progress in AI. And this trend could be dangerous.

Many prominent personalities as Elon Musk or Stephen Hawking issued warning before unseen hasty uncontrolled development of artificial intelligence and its implementation [1, 2]. The managers of commercial companies are forcing developers to release new untested applications on market in the view of huge profit just from being first on the market. No one is thinking of responsibility or accountability of "artificial intelligence" when it is going to be freely released to indeterministic human world. More, average IQ and creativity of the human society is decreasing while dependency on the information on the IT technologies is increasing [3], so the actual acceptance of any AI technology

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 605–610, 2022.
https://doi.org/10.1007/978-3-030-85540-6_76

increases and what's more, it will be welcomed without perception of the danger for whole population.

The questions of ethic from the points of view of AI application had been dealt at many occasions. Even the extensive development of artificial intelligence should provide a great benefits and convenience to mankind, it also takes along ethical issues such as responsibility, human rights, generation crisis, prejudice, information evaluation, etc. which are demanding our attention. Therefore, we should emphasis the scientific and technological ethics and create ethical standards for artificial intelligence, make stronger the supervision of artificial intelligence development and improve the public ethical concepts. Such a way artificial intelligence can cope with the risks and challenges under the guidance of scientific and technological ethics – see e.g. [4, 5] or [6]. One of the most critical application of the AI is automated driving especially of cooperative vehicles, where some attention had been in the area of cyber security [7], but the deep analysis of whole system is very complex.

2 Cooperative Vehicles as the Complex Tightly Coupled System

Before we will go to the problem of the responsibility or accountability in the case of some catastrophic failure of important part of the transport system we have to state that most of the analyses already done are studying the individual behavior of AI in the single isolated vehicle out of the impact of fully connected system. According to Perrow normal or system accidents[1] are accidents involving unanticipated interaction of multiple failures in systems with high-risk technologies [8]. These kinds of accidents, as he stressed, form quite different case from component failure accidents, which involve the failure of one component[2]. The important issue for the study of responsibility of AI based system is his variation of systems which should be linear or complex and can be tightly or loosely coupled[3]. In his understanding linear interactions are expected and may be planned, but quite visible even if unplanned. Complex interactions are those of unfamiliar sequences, or unplanned and unexpected sequences, and either not visible or not immediately comprehensible.

So what we are studying is a complex system, which is tightly coupled, one event follows rapidly and almost invariably another with a little opportunity for human intervention[4]. According to Perrow's conclusion in such a case, where systems are both complex and tightly coupled, accidents are inevitable. And when the system involves a high-risk technology, disaster is inevitable. As can be seen, where a system is both, tightly

[1] These terms are used interchangeably.

[2] The failure of one component may lead to the consequential failure of other components, all in a predictable manner.

[3] Actually these two terms are not precisely defined anywhere in the book, but used in common sense.

[4] Tightly coupled systems are understood as highly automated systems. The loosely coupled system are in Perrow sense the system where things developed more slowly, where different outcomes are possible and where is enough time and opportunities for human intervention, before they become serious.

coupled and complex, these two imperatives pull in opposite directions. While tight coupling requires centralized authority, complexity requires autonomous decision making. This conflict makes it impossible to develop an authority style which will reduce the risk of accidents in complex, tightly coupled systems. This explains just why in complex, tightly coupled systems accidents are inevitable.

Another conclusion from Perrow's theory could be achieved with complex tightly coupled systems - multiple failures that interact with each other will occur, despite efforts to avoid them. It points out another characteristic of complex tightly coupled systems - failures relate more to organizations (structures and processes) rather than technology, and big accidents almost always have very small beginnings.

Going back to the problem of responsibility in case of AI driven cooperative vehicles we have to describe the basic structure of the system, which will undergo dynamical changes in the time and communication structures in the whole system. So we have many communication entities, each of them connected to its environment, while the environment is also dynamically changing in time.

3 What is Vehicle Grouping and Tasking?

Let's have a set of self-learning communicating system organized in groups which communicates inside the group and with its environment. The self-learning entity, in our case single AI, starts with some embedded information base, achieved in the state of the design and set of "knowledge's", which are planned to get e.g. expected traffic density, weather, status of the car etc. Other information is obtained in time from the environment e.g. the nearest cooperating vehicles, information on the traffic and the road quality etc. As the environment changes, the information gathered from the environment is changed frequently and processes of AI inside the vehicle has to search for the optimal solution continuously or in every time slot. But all vehicles in the environment has to do the same – searching the optimal solution for its own decision, based on the information acquired. Moreover, we have to expect some noise, stressed time limits for communication and processing, and small changes of the information inside the group of vehicles. In this case, we are running into behavioral problem of communication inside the "community", where "community" is equal to group, structural changes in the "community" and manifestation of the "community" itself to outside.

The problem of such "community behavior" had been studied by psychologist Irving Janis [9] who coined the term "groupthink". Groupthink refers to a set of dysfunctional decision processes used by highly cohesive groups, leading them to ignore alternative courses of action and to irrationally discourage the expression of disconfirming opinions[5] [16]. If "the community" will be represented by a group of cooperative vehicles with the same AI ability, behaving the same way, such group will be highly cohesive, so we should expect similar behavior of AI as groupthink is. To describe the situation in the spirit of Parkinson's Law - the more amiability and esprit de corps will be among the members of a group, the greater the danger exist, that independent critical thinking will be suppressed

[5] Irvin used his theory and to analyze retrospective accounts of historical events (such as The Bay of Pigs Invasion) that were labeled as political fiascoes and example of faulty group decision making.

and replaced by groupthink. Furthermore, using conclusion of Perrow's normal accident theory, the small changes as an error or noise in the communication channel, can result in irrational and abusing actions directed against outgroups and subsequently to massive collision.

The solution of the groupthink effect remains in keeping diversity inside the group, which is, in the case of AI, unrealistic. Similar, but more softly conclusion comes from game theory, where it has been shown that solution of the problem by systems on the same level is less effective and more erroneous than solution found by systems on the different levels. In all cases, the systems automated on the same levels and on the same principles lead to the vulnerable system of systems prone to be self-destroyed.

The conclusion presented above, based on sociological and psychological models, are not quite satisfactory as far as the security or safety of the system itself is concerned. Higher risk that system of the same AI's will be prone to self-disaster and in such a way become unsecure for its users is noticeable. Moreover, we had not expected, that some part of the system of systems will be hostile entity – AI attacking other system with goal to destroy whole system of systems. Paradoxically, this case should lead, with respect to the diversity, to the heterogeneous system of systems, which would be more stable then homogeneous system of the same AI's[6]. The stability of such system of systems will be the major goal to achieve. Other parameters, such as effectiveness or robustness will be negligible from point of view of security that means stability.

Searching a general rule how to make system of AI system stable, we can use some standard mathematical methods as e.g. evolutionary game theory to study a cooperative conflict in multiagent systems [10] or [11]. It has been found that to achieve Nash equilibrium in the game where two entities are coexisting[7], an individual is inclined to choose the strategy, which is contrary to the strategy choices of their opponents. In the system with two communities, this conclusion is still applicable and it fits to our previous findings.

4 Is There AI Responsibility or Accountability?

As it has been discussed above, the system of systems where basic elements are units equipped with AI and all AI will be equally or semiequally "intelligent" can form rather unsafe system for itself and for its users. So discussion of responsibility of such a system, when something happens, is appropriate. As far as the simulation such a system is concerned, the most of the works is done considering small samples or limiting condition. So, up to now, we are not able to predict, what actually should happen. The scale of scenario goes from "nothing happens", system of systems will be stable, to the worst case of mysterious disaster. Who will be responsible for such a catastrophe and who will we hold accountable is subject to philosophical and legal considerations, but without a clear conclusion.

[6] Compare e.g. "Why dissent is vital to effective decision-making" [15].

[7] The typical games of this type include the "snowdrift game" or "hawk-dove game".

Self-driving cars provide very straightforward example because such car can move moral responsibility away from the human crew inside vehicles. If a vehicle shall not be responsible, to whom the responsibility should be attributed? [12] And especially in cases where human designers of the machine cannot predict or explain actions of the machine ahead. Major question is, how can we ascribe moral responsibility to AI. What is machine ethics and what it means to a machine to be morally responsible?

According to Strawson [13], individuals are morally responsible when they are properly subject to reactive attitudes such as blame or resentment[8]. Strawsonian accounts are standard accounts of moral responsibility, that begin with the social and emotional foundations. They provide a clear set of standards that artificial intelligence would have to meet. In another words, to gain moral agency; it provides a way to incorporate artificial intelligence into the preexisting moral world. The agency condition means that human or an artificial intelligence satisfies this condition when it performed the act autonomously, is aware of what it is doing and what the consequences of doing so will be, and that it has some reasons to do what it does.

Regarding the condition above, we have to distinguish between strong artificial intelligence, which acts indistinguishably from normal agents and has an inner life, and weak artificial intelligence, an AI that just mimics human behavior successfully, but has no will. An artificial intelligence's moral responsibility depends whether the moral community is disposed to respond to the AI with interpersonal reactive attitudes.

Therefore, to rightly respond to artificial intelligence with reactive attitudes, it must have, and not just seem to have, capacities of moral community. In the view of previous division to strong and weak AI, artificial intelligence is morally responsible if and only if it is sort of strong artificial intelligence. Any strong artificial intelligence with capacities for reactive attitudes is morally responsible on broadly Strawsonian picture. Even fully autonomous cars, at least as we currently consider them, will not have the necessary capacities to be morally responsible for their actions. They will fall into category of weak artificial intelligence or into responsibility gap[9].

So, our question of the responsibility and accountability returns in the circle. Nevertheless, Tollefsen gives to us an explanation inside the limits of Strawsonian framework. He argues that groups, social institutions, and corporations can serve as agents in a Strawsonian framework precisely because they have the required capacities of moral agents [14]. There is not meant the individual member of a group, but rather the group has these capacities and bears moral responsibility[10] - humans have reactive attitudes towards groups, not toward a particular person, but to a company.

Based on previous analysis we can conclude that at the present, moral responsibility lies on the company who introduce the autonomous vehicle equipped with the weak

[8] Strawson argues that our reactive attitudes, such as gratitude, anger, sympathy etc., towards others and ourselves are natural and irrevocable. They are a central part of what it is to be human.

[9] However, it is important to consider whether we can ascribe moral responsibility to artificial intelligence anywhere near developing such a technology.

[10] She coins the terms "shared moral responsibility".

AI. Not the CEO, not the programmers or implementers[11]. But the whole company or corporation, as state of art in the autonomous vehicles is.

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[11] There is a moral responsibility gap in moral responsibility. If programmers are not able to predict or explain the actions of their artificial intelligence design, then programmers cannot be held accountable for their AI's actions.

Model for Optimization of Spaces Through the Redistribution of Warehouse and Application of Lean Logistics to Reduce Service Times Within an Air Cargo Company

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Abstract. This paper deals with the combined implementation of the optimal redistribution of warehouse stations through layout analysis, as well as the use of lean techniques in warehouse operations of an air cargo company. The study highlights the effort to improve operations within the warehouse through the use of existing lean tools that allow eliminating waste (activities, materials, among others) that do not generate operational value, as well as improving and expanding the warehouse's storage capacity using the plant distribution tools and block stacking in order to maximize the allowed load and maintain the proper order that allows the continuous flow of operations within the air cargo warehouse.

Keywords: Layout · Lean · Distributing · Warehouse · Optimization

1 Introduction

The freight transport sector is currently divided into categories, within which are: rail, road, sea and air transport. Air is the most flexible in terms of time, which is why it is considered one of the most important for the development of logistics operations and international trade. Therefore, this category represents 12% with respect to the entire sector within the GDP share. In 2017 it managed to obtain a contribution of 3.7% compared to the 3.5% obtained in 2016, closing in 2018 with a total participation of 5.2% within GDP.

This study seeks to generate a model that allows integrating a new management of spaces for the optimization of the warehouse together with the Lean Logistics methodology in order to increase the net storage capacity, as well as the reduction of the operating times of the personnel, with the purpose of minimizing the attention time, improving the quality of service and mitigating the loss of market share.

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 611–617, 2022.
https://doi.org/10.1007/978-3-030-85540-6_77

From this, we will proceed with identifying the main causes that originate the problem by taking time, delimiting the current process flow, reviewing and modifying the layouts using space distribution tools, identifying agents, operations and designing scenarios with the which will proceed to perform comparative analysis under simulations to choose the best option. In this sense, the simulated scenario will be analyzed against the current one in order to obtain the performance of the proposal.

2 State of the Art

2.1 Space Management

The management of spaces generates a direct impact on the quality of the service within the warehouses, since having an inadequate management can cause operational disorder, hindering the treatment and increasing the processing time of the loads, leading to an increase in the service time towards customers. Given this, space management aims to optimize spaces, reduce operating costs and generate the shortest travel time between operations. Space management is attached to various analysis parameters within warehouses, including: vertical positions, horizontal positions, package measurements, pallet measurements, industrial rack measurements, among others.

For this reason, within the management of spaces, to analyze and define a structure of operational facilities or warehouses within a company, ABC analysis is used in most companies in the manufacturing sector, together with the study of distance travel by materials processes or products that provide greater profitability to the company. Under scenario simulations it is sought to identify the viability of the multiple design options in order to identify the viability of the analysis [1]. ABC analysis allows determining the main materials or products with the highest profitability within the company; However, for logistics services sectors, this analysis is not optimal, since there may be different types of products that contemplate variable size and volume, before this, the use of space management models is related to the implementation of racks or racks with different heights, which will be determined based on simulations with historical data of stored materials to define the optimal height of the racks or racks that allow the majority of products to be stored in the least possible space within warehouses [2].

Likewise, within the management of spaces, an important parameter to evaluate is the employability or optimal occupation of vertical spaces, which together with the study of rack heights seeks to store the greatest amount of materials in less space, to evaluate the employability of vertical spaces. The robust design model (RDM) or block stacking model is used, a model that requires historical information regarding the number of materials or products transferred to the warehouse, the volume, weight and dimensions of the same, the information is entered into a Decision algorithm, which will provide referential data regarding parameters of products or materials to manage storage by differentiated pallets, information that will be useful to generate the design of spaces within warehouses for the manufacturing and service sector [3]. The robust model seeks to reduce, in addition to spaces, the cost of storage by occupied positions, the model is modified through the analysis of storage policies based on classes, under the use of mathematical models that allow optimizing the horizontal space by determining the depth of lanes and the relationship of aspects of materials or products to minimize the

total cost of space and material handling, the combined model can be used for random storage, for materials with different parameters at the level of weight and space [4]. The space management models are adapted to a necessary standard for companies, which is why an ideal model for the management of warehouse spaces is given under the design of spaces using various plant distribution tools; However, they are evaluated under simulated scenarios, in which values directly attached to the needs of the companies are taken, allowing flexibility in the long-term design [5].

2.2 Lean Logistics

The Lean Logistics philosophy allows to establish which processes are fundamental in an organization and which can be eliminated, in turn this change allows to achieve better efficiency in time and costs. This philosophy is related to understanding and identifying causes of problems that arise in the processes from some parameters that are established for the development of research.

For the improvement proposal to be adequate and this new storage model to be used efficiently, the starting point is to establish the main approaches by which a company must make the right decisions for changes in the processes through the simulation of historical data. That was generated, thus showing the prediction precision with different confidence levels and the prediction specificity and sensitivity curve [6].

Obtaining relevant and quantitative information to determine waste within the warehouse is essential as this allows to guarantee that the level of waste reduction practices in the warehouse is met based on the Delphi method [6]. In addition, the effect of the level of warehouse waste reduction practices on business performance is fully mediated by warehouse operation and distribution [7]. Likewise, it should be noted that the distribution of a warehouse, the latter having to be orderly and optimal, is important since it facilitates the task of preparing orders, provides a more careful environment and it is easier to find where each item is located. work, reducing delays, work inefficiency and customer dissatisfaction [8]. Likewise, organizing and controlling the operations and flows of goods in the warehouse, in accordance with the optimization of the warehouse network and/or logistics chain is essential to improve the productivity and performance of the company, facilitating potential savings and increased utilities. Therefore, proposing the application of tools such as VSM, identifying and eliminating waste generates a better impact on the result [9].

The application of the Lean philosophy achieves, as its main objective, the increase in the productivity of the processes, in which the TOC methodology seeks to eliminate waste and elimination of waste, inefficient operation cycle time, quality defects in manufacturing, unnecessary processes, resource utilization, excess inventory in order to achieve a more adequate and integrated storage [10].

Analyzing the failures in the different process lines in a company helps to identify that, possibly, downtime is generated in the production system that leads to a delay in the delivery of orders to the customer is important in order to improve processes [11]. For this, in all research it is essential to find the main cause and variables of the problems related to the existence of this incidence. The findings of this research allow a better understanding of the variables that generate the defect and that are not only failures in

materials, but also in deficient processes, which influence the efficiency of the production process [12].

Companies must focus on productivity and cost reduction; therefore, the application of efficiency improvement methods is essential and important for companies in order to maintain and increase their competitiveness and provide sustainable production [13]. Therefore, with the development of a new combined efficiency improvement method that basically applies the improvement methods oriented to the Lean value, but also uses the FLD (facility layout design) method simultaneously to obtain uniform results, more significant improvement of efficiency, cost reduction and improvement of various KPIs. In that sense, due to Lean methods, the following KPIs can be improved: p. lead time, productivity, number of workstations and operators, labor cost, inventory, and various quality indicators (eg product quality, ergonomic workplace), etc. [15].

3 Input

After the search and review of the literature, the contribution of this article is proposed, which is based on the use of Combined tools and methodologies found in the literature, which include studies for the development of an adequate model for the context of this case study, the search and analysis of the literature allowed finding tools and models on the management of spaces and lean methodology. logistics, which will be of importance for this study.

3.1 Proposed Model

The proposed improvement model has as main objectives the reduction of the processing time per load, the reduction of rejected loads, order within the warehouse and the improvement of the processes. The proposal of the model originates from the analysis of the case study by reviewing the historical information, going on to the analysis of the diagnosis of the problem and review of the literature in order to compare scenarios, models, tools and results that resemble the needs of the case study. The review and extraction of the information made it possible to cover studies and suitable models for the modification of spaces within the warehouse, as well as the application of tools of the Lean Logistics methodology.

In order to provide a better perspective of the model, each phase of the development stages of the proposal will be explained. Each of the phases are made up of activities and tools related to space management and Lean Logistics methodology.

3.1.1 Space Management

The first stage of the proposed model covers the management of spaces, in it possible alternatives are proposed using various floor distribution tools, which will be evaluated through the use of a comparative logical algorithm, which receives and compares important parameters for each type of space. companies or sectors. To do this, the main parameters must be defined first, which will be important for the case study, in this sense the following parameters are considered: net tons stored, distance traveled between processes and the total time since the load registration until storage. In addition, the main

products or materials that are stored will be determined since the case study refers to an air cargo company, for which the products or materials that generate greater profitability to the case study are taken into consideration in order to evaluate the plant distribution tools that are most closely related to the case study.

3.1.2 Lean Logistics

The purpose of the Lean methodology is the synergy between the activities or processes within a company, therefore it seeks to integrate all the processes, in the second stage the lean logistics methodology will be used in order to integrate the processes within the warehouse, to Based on this, as the first activity, the process flow within the warehouse will be designed and analyzed to identify those processes that do not generate value, for this a process identification template will be used as shown in Fig. 1. Identify and maintain those activities or processes that are required for the logistics flow. Likewise, prioritize the work areas according to the diagnosis of the case study.

SECCION:
ZONA 5S:

SUB-ÁREA:
FECHA:

LISTADO DE CLASIFICACIÓN							
ANTES	DURANTE					DESPUÉS	
NOMBRE DEL ELEMENTO	NECESARIO		INNECESARIO	OBSERVACIONES		STOCK	
	OPERATIVO	REPARABLE		FREC. DE USO	LUGAR. ALM.	MAX	MIN
REALIZADO POR:	APROBADO POR					FECHA:	

Fig. 1. Evolution of accepted loads per year expressed in thousands of kg.

To mitigate the impacts of time and costs of the main problem, mainly directed more to the operational part of the new process established for the warehouse, establishing those points and committing the company's staff will ensure that this improvement is continuous and, above all, a more efficient and integrated solution is obtained.

Finally, with the redistribution and allocation of the new spaces correctly establishing the type of load,

4 Validation

4.1 Validation Scenario

This article shows a model that complements the use of plant distribution tools with the Lean Logistics methodology. The implementation of the new combined model will be evaluated through the use of system simulation software, Arena, which will have as its main input the times for each process, which will be obtained from the time study of the case study. Finally, the simulation is carried out under a 95% reliability percentage for the purpose of obtaining results.

According to the case study, the root causes that originate the increase in load processing times from registration to storage were evaluated, the first root cause was detected, with a value of 60% of importance being the distribution of the warehouse Due to the unplanned zoning of spaces assigned for stored cargo, the second root cause with 30% importance refers to labor, due to the high turnover of personnel in the Cajamarca branch, which is replaced With operators without previous experience, the last root cause with 10% of importance identifies the lack of training of the security and cargo personnel regarding the use of tools and machines to speed up their operations.

4.2 Design Validation

The proposed model is focused on the air cargo logistics sector that present a considerable diversification of materials or products transported.

4.2.1 Lean Logistics

To achieve the objectives set in reducing time and costs for the cargo storage reception process, the value of each area that involves it is established for the final process. In this sense, when applying the 5S as part of the Lean Logistics philosophy, the steps of selection, order, cleaning, standardization and discipline are established based on the current situation of the warehouse in Cajamarca.

5 Discussion

The objective of the model has been to totally avoid the loss of income due to the non-reception of cargo, reducing process times and increasing capacity; However, due to factors inherent to the operation, the goal has not been reached 100%. With the proposed model, despite the fact that the ideal scenario has not been reached, the goal set is exceeded. The main reason for looking for why it is not possible to reach the ideal scenario is because there are operational and climatic factors that will indirectly affect the result and these cannot be controlled. Likewise, although the new process flow has been proposed, it is still necessary for those involved to get used to this new work scenario and make the most of the capacity and tools implemented, which include new workspace, machinery and training.

6 Conclusions

This work proposes a model, based on the Lean Logistics philosophy, which, when a new Layout was made and the necessary logistics tools were applied in a 4-month period of the project, managed to increase its reception capacity and income by sales and reduced lost hours and overtime costs. Therefore, the problem was reduced by 18% versus the scenario found.

The model was implemented from a simulation based on the times and movement of tons handled with real and current information, since all those involved were interested from the beginning for the implementation of the project itself.

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Smart Controller for Solar Thermal Systems

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Abstract. The paper presents the development of an innovative solution based on a smart controller for solar thermal systems. The controller can intelligently optimize all sources and consumers of heating energy in order to maximize the savings. It has an easy to use user interface that allows advanced configuration. The solution consists of solar controllers, other IoT devices and a platform that provides remote control, extended user interface, and a number of different services.

Keywords: IoT · Solar energy · Smart home · Systems engineering

1 Introduction

The heating takes a major share (80%) of the energy consumption in the residential sector. Households need thermal energy, but most of them use conventional energy causing pollution and CO2 emissions, instead of using solar energy. Despite the availability and sustainability of solar energy, its usage is much less than the potential, while thousands of people are dying each year because of pollution caused by fossil fuels burning.

The efficiency of thermal solar panels is 80% compared to PV panels with 15% only, but there are still not so widely used because of the following obstacles that the proposed solution overcomes [1].

- The available high-end smart controllers are very expensive;
- Lack of competency about haw to install and configure the devices;
- Difficult incorporation with the existing systems;
- Uncertainty about Return of Investment (ROI).

The goal is to provide a solution that has the following features:

- Fully configurable input and output interfaces
- Extra savings achieved by smart control of the providers (solar panels, solid and liquid fuel boilers, electrical heaters, etc.) and consumers (boilers, heating radiators, swimming pools, etc.) of thermal energy.
- Affordable price thanks to the cost-effective design.
- Easy incorporation with the existing systems.
- Certainty about ROI provided by calculating of solar to other energy ratio.

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 618–624, 2022.
https://doi.org/10.1007/978-3-030-85540-6_78

- Control of the pan/tilt of the solar panels (according to daily sun movement) increases the efficiency and also solves the problem with extra energy
- Detection of failures provided by intelligent algorithm and output ports equipped with electrical current meter allows identifying pumps circuit cut-off, etc.
- High reliability and ultra-low energy consumption of the device.
- Variety of user interfaces and connectivity options

A typical solution consists out of the following elements:

1. A controller with connection to local IoT devices and with algorithms to optimize thermal heat balance in the building and to minimize the use of fossil powered thermal energy.
2. Devices (via other suppliers) such as:

    a. Sensors to measure temperatures, flows, pressure, and other parameters
    b. Actuators to control heat production sources, to control pumps and to control valves

3. A platform that connects all Controllers and supplies:

    a. Remote control and notifications
    b. Data analytics
    c. Additional services for extra savings (Weather data, etc.)
    d. Advanced configuration options
    e. Option to connect other IoT devices

The following sections describe the main components of the solution and their contribution to achieving the goals.

2 Smart Solar Thermal Controller

The main goal of the controller is to optimize all sources and consumers of heating energy in order to maximize the savings. This is achieved by using the available information and applying advanced control algorithms.

For example, the user can set the required amount of hot water for a specific date and time, so the controller will fulfill the requirements using as much solar energy as possible. For such task, the controller measures the actual power produced by solar panels, the power of the electrical heater, ΔT between the current and required temperature of the water tank at specific time and ΔT between the current time and that time.

As mentioned earlier the uncertainty about ROI is one of the major reasons discouraging people for investing in such technology. The controller provides advanced monitoring that allow the user to see the solar to other energy usage ratio, i.e. to track the return of his investment.

Other option for potential savings is use the weather forecast to predict whether it is more efficient to use the cheaper night electrical energy.

The controller interacts with different thermal appliances, which increases the possibility of failure in the systems, since there many components. Such kind of failures could lead to costly in terms of time and money issues. The controller provides several methods for advanced protection:

- For five wire motor-driven valves, it uses the information from the limit switches in order to guarantee that the commands are executed correctly.
- For the closed systems, it measures the pressure level in order to detect leakages and other failures.
- The output ports are equipped with an electrical current meter for power measurement that allows detection of failures such as pump circuit cutoff, etc.

Additional option is the two dimensional solar tracker that can control the pan/tilt of the solar panels array according to daily sun movement. This feature increases the efficiency and is very useful especially when there is a limited space on the roof for extra panels.

It also elegantly solves the problem with the extra energy during the hot days by automatically turning the array on the opposite sun direction.

After recovering (in case of power failure) thy system gets the actual time and date from NTP server (suppose Internet connection) in order to calculate the optimal pan/tilt of the solar panels array.

Currently there are two models, one for domestic usage and other for industrial applications. The main difference is that the last one has more inputs and outputs ports.

The controller is based on ESP32-Pico-D4 [2] System-in-Package (SiP) which simplifies the PCB design and increases the reliability.

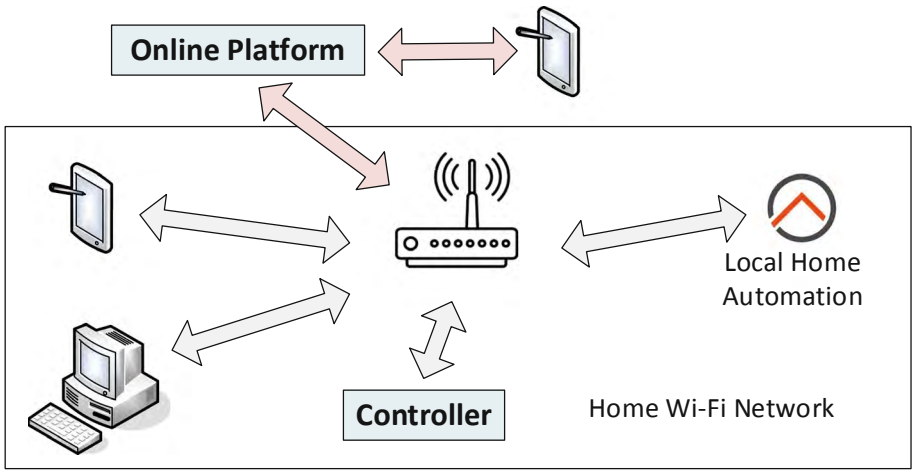


Fig. 1. Various way to access the UIs of the controller.

The controller has rich connectivity (Wi-Fi, Ethernet and Bluetooth) and several UIs options available: display, own web UI, existing home automation (openHAB [3], Home-Assistant [4], etc.) and our platform, Fig. 1.

The usage of MQTT protocol allows integration with existing home automation plat-forms via Homie specification [5] and the platform for remote access and control.

3 Web Platform

The web platform provides remote control, statistical data and advanced UI.

When the controller connects to the Internet it sends its unique Id to the platform, so the user does not need to enter it manually, as shown in the figure below. This process is required only for the first time and once the users are registered, they can use the platform. Then the controller sends MQTT messages to represent itself and starts sending measurements data (Fig. 2).

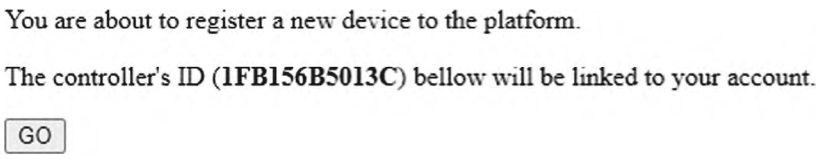


Fig. 2. The message displayed to the user during the initialization of the controller.

3.1 Architecture

The platform is designed to adopt a lambda architecture in order to process data in a more efficient way. It processes two kinds of requests - one for current data and one for statistics. The first one displays in the interface current/live data from the received sensors and the latter one displays data for a bigger period of time after querying the database (Fig. 3).

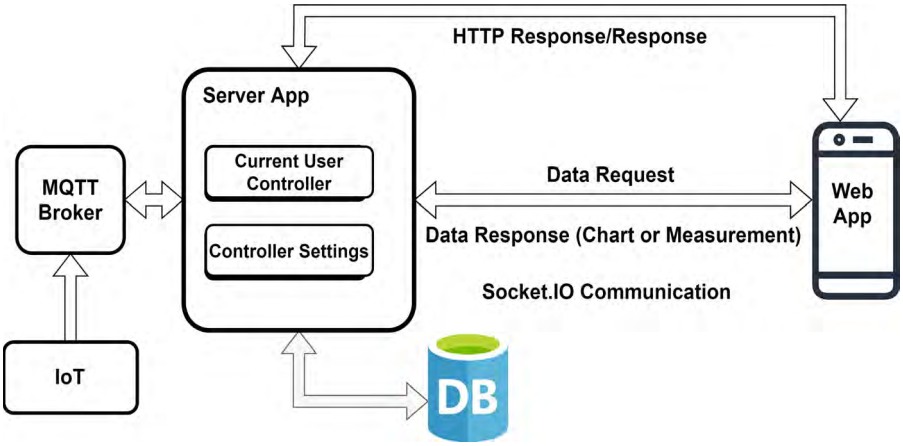


Fig. 3. Architectural overview of the web platform.

The MQTT [6] protocol was chosen as the message communication mechanism since it has been widely used and proven in IoT architectures. Last Will and Testament (LWT) feature of MQTT is used to notify the platform about an ungracefully disconnected device.

In order to reduce data storage and network traffic, the measured data is sent to the platform only if differs from the previous measurement. That allows fast response time with low network traffic, but can be more challenging for data visualization.

3.2 Database

The structure of the DB allows to add (and remove) different devices without changing the structure.

Additional table in the database allows to automatically associating the controller after replacement. Using the identification numbers of the sensor and other information about the systems, the platform can identify that the controller has been replaced, which significantly simplifies the support of the system (Fig. 4).

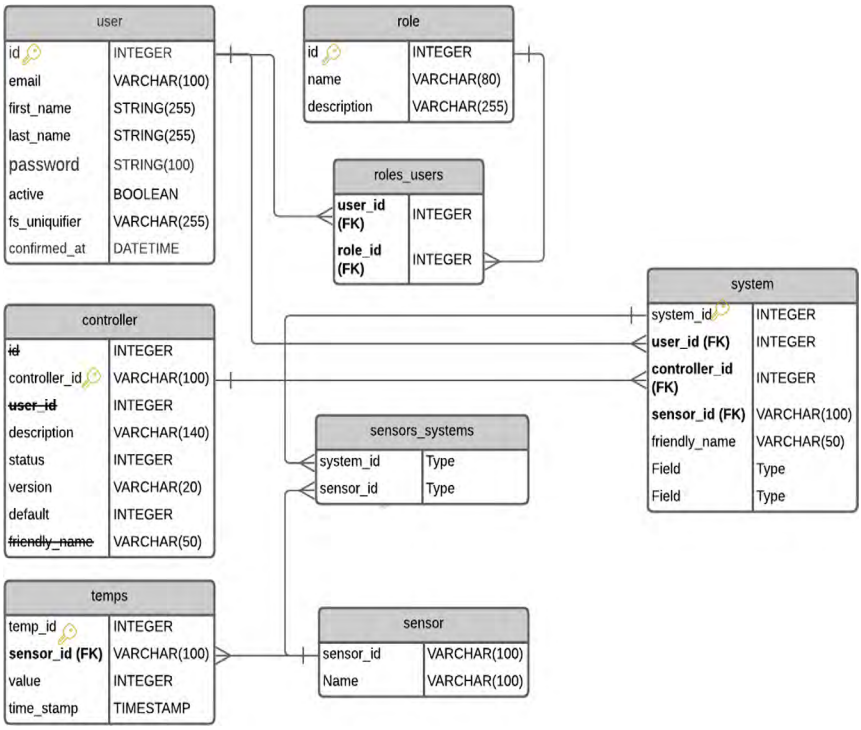


Fig. 4. Section of the database schema.

3.3 User Interface

The newer version of the UI presents the data in a more user-friendly and easier-to-use way. It, also, offers additional features such as an integrated weather forecast API.

In Fig. 5 below a screenshot can be seen, where the user is presented with current sensor measurements (upper half of image) and aggregated data for a chosen period of time.

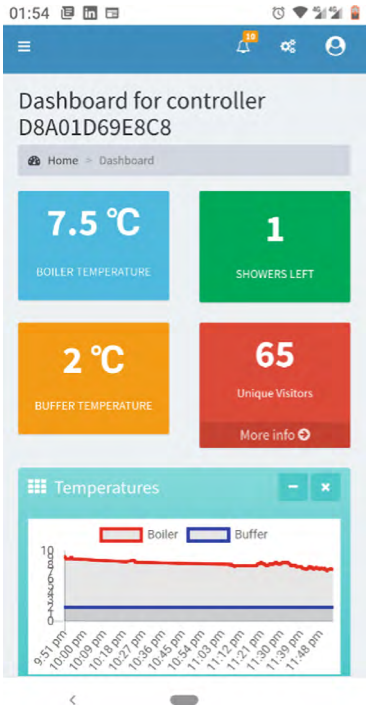


Fig. 5. A sample screen of the UI.

4 Conclusion

The proposed solution is designed for single households, but can be used in communities, industrial and office building, etc., allowing energy saving and sharing.

It allows increasing the share of freely available and clean energy usage. The precise control, monitoring, and effective usage of solar energy contributes to significant cost reduction. As future work, we aim to develop a visual programming tool that allows the users to incorporate external components to the system in a convenient way.

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Calculation of the Probability of Landslides Caused by Precipitation Applying the Janbu and MonteCarlo Method in Skarn-Type Mineral Deposits

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Abstract. In this research, we will focus on analyzing the influence of the rains on mining companies in the district of San Marcos in the department of Ancash, Peru. To do in this investigation, a stability analysis of slopes with limit equilibrium methods, being the Janbú the one selected for said study. On the other hand, it calculated the probability of failure of the slopes using methods probabilistic such as Monte Carlo. Such studies mentioned were applied with the help of the Slide software.

Keywords: Material slippage · Rainfall · MonteCarlo · Probability of failure · Janbú method

1 Introduction

Mining is one of the economic activities that has evolved over time, being in turn one of the most important sources of income in Peru and the world. However, it is in turn one of the riskiest economic activities that exist. It is for this reason that there are many types of investigations into the causes of accidents that exist during the mining process. According to annual reports made by entities of the Peruvian state (MINEM), there are different causes of accidents in our country, the landslide being one of the most recurrent at present, it is approximated that 17% is due to landslides or landslides [1]. These events in turn have different causes, one of the least studied in Peru being rainfall.

The slipping of material is one of the threats that generates a greater risk in the mining operation stage, so it is essential to calculate the safety factor, especially in mines located in areas where changes and weather conditions such as rainfall influence, since that a material slide could occur, which is a movement that releases large masses of earth or rock that goes down by gravity until it reaches a flat place, the slide is related to accidents

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 625–633, 2022.
https://doi.org/10.1007/978-3-030-85540-6_79

in operations, such as: damage to the integrity of the collaborator, damage to equipment, stoppage of production and generation of expenses.

To analyze the stability of slopes, there are different methods, these can be numerical or limit equilibrium, this last method is the most used due to its simplicity and because the value of the factor of safety coefficient is not far from the real value. It is essential to calculate the safety factor, especially in mines located in areas where changes and weather conditions such as rainfall influence, since a material slide could occur, which is a movement that releases large masses of earth or rock that descends through the gravity until finding a flat place, the slip is related to accidents in operations, such as: damage to the integrity of the employee, damage to equipment, stoppage of production and generation of expenses.

2 State of Art

2.1 Landslide Analysis with MonteCarlo

A relevant threat that affects mining operations are landslides caused by rainfall, since surface mining is located at high altitudes, these events are the cause of economic losses of more than 4000 million dollars worldwide according to [2]. Different investigations were found where landslides are analyzed using probability methods, to evaluate the probability of landslides, the rainfall events evaluated in a minimum of 10 years were taken as input data, since they assume that the rainfall of those years are the ones that triggered at least a percentage of landslides around the study area [3, 4]. In the investigations related to the mass landslides that occur due to the influence of rain and affect the stability of slopes, the investigations have analyzed from a rocky slope analysis approach and under the infiltration conditions of the rains. For the MonteCarlo parameters, the change in pore pressure and the decrease in rock resistance due to the weakening effects produced by water were considered in the slope stability analysis [3, 5].

2.2 Union of the Probabilistic Method with the Limit Equilibrium Method

To obtain results with a lower error range, many authors have implemented a numerical method together with a probability method, especially in the last years in mining to calculate the probability of failure of a slope. The construction of an open pit begins with the design of a bank, for this reason the safety factor is first evaluated, to maintain the stability of the slopes, there are different slope stability analyzes, one of these being the limit equilibrium methods (LEM) that serve engineers as a tool for calculating the factor of safety. LEMs are statistical methods based on a physical theory and presented as translational collapse mechanisms [6, 7]. Different criteria are used to calculate the factor of safety (FoS): linear Mohr-Coulomb (with parameters φ and c) and the Janbu correction method of vertical cut, which use the LEM to take into account the influence of the uncertainty [8]. In this research, the Janbú Method with MonteCarlo will be used, taking into account the variability of the soil parameters: cohesion, specific weight and friction angle [9]. Both methods will be executed in Slide software due to the complexity of the algorithm [10].

2.3 Probability of Landslide Calculated with MonteCarlo and Janbu

To calculate the probability of landslide, the Monte Carlo probabilistic method will be applied, the first step to follow for this methodology is the identification of the necessary elements, such as the tasks and risks that will be considered important in the study to be carried out [11]. The first step is to identify the parameters necessary for the study, such as the height of each soil or level, slope of the slope, soil cohesion, specific weight of the soil, height of the water table and the geotechnical profile. After this, the depth factor is calculated, which is the height of the water table between the depth of the foot of the slope. Subsequently, the coordinates of the critical circle are obtained with the help of the Janbú tables and the average cohesion and the reduction factor are calculated [12, 13].

3 Input

3.1 General Contribution

Joining a probability method together with a mathematical method will provide a more accurate result with regarding the probability of failure. Different simulations will be carried out with respect to the area of the zone, in order to make a comparison considering two conditions of the study area, an initial condition where rainfall is not considered and another where meteorological information from recent years was incorporated. The data from the Yanacancha meteorological station will be used for the respective analysis of the accumulated rainfall from 2003 to 2019.

3.2 Detail Contribution

Calculation of the Water Table. As an extra coefficient, the water table was calculated for the last 13 years, in order to compare the change in the safety factor and the probability of failure in the study area. First, the flow of rainfall in the area to be studied was calculated.

$$\boldsymbol{Q = CiA} \tag{1}$$

Where:

C: Runoff coefficient (dimensionless) i: Precipitation intensity (mm/month/Ha) A: Tributary area (Ha)
An area of 0.005 ha was assumed.

$$\mathbf{Q = 0.535 * 20510.3 * 0.005} = 54.9$$

The operation gave us an approximate flow of 54.9 L/period studied, which would be equivalent to 0.0549 m^3/period studied. By knowing the area to be studied of 500 m^2, we were able to calculate an estimate of the height that will be added to the water table, this being 0.001 m.

Geology Analysis of the San Marcos Area. Analysis of different igneous, sedimentary and metamorphic rocks from the Ancash area was collected. In this research work he focused on 3 different types of rocks, these were: limestone, granite and skarn, this is due to the abundance of these massifs within the area to investigate.

Slope Modeling. To perform the slope stability analysis and calculate the safety factor, a 40° angle of inclination was used and the minimum dimensions recommended for a simulation were used. With the known coordinates, the approximate model of the slope to be studied was generated and the block was segmented, taking into account that 75% of the sterile material is limestone, 15% is segmented as Granite and the remaining as mineral obtaining as a result the following (Fig. 1).

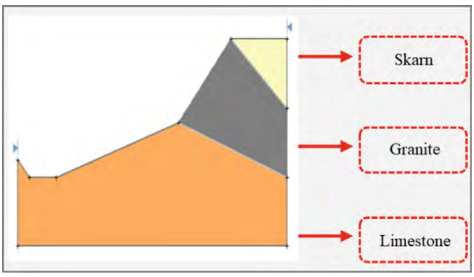


Fig. 1. Slope model

3.3 Indicators

The rocks have different geomechanical properties that could influence the sliding, not only the porosity or permeability due to rain seepage, but also the type of rock found on the slope and the seismic forces, which is why they were implemented. The following indicators for the slip calculation.

1. Cohesion: It is the binding force that exists between the mineral particles that make up the rock.
2. Angle of friction: It is the angle of friction between two planes of the same rock.
3. Volumetric weight: Total weight of the rock, all dimensions of the massif are considered.
4. Seismic force: Horizontal seismic forces of 0.134 and vertical forces of 0.2 were added, in order to have a simulation closer to reality.

4 Validation

4.1 Validation Scenario

This research was based on the San Marcos area, in the department of Ancash, this unit was chosen due to the sequence of rainfall that occurs from October to March. Meteorological and hydrogeological studies were carried out to analyze the influence of rain seepage on the water table.

4.2 Previous Studies

The present research used as a basis the study carried out by Obregon (2019) who implemented a limit equilibrium method called Bishop together with the Probability method to obtain the probability of failure in an open pit mine [12]. This research was also based on the study by Fernandéz (2019) for the calculation of the 10,000 iterations of the input parameters.

4.3 Validation Design

Calculation of the F.S. The calculation of the Safety Factor of the slope was carried out in three different scenarios:

1. Before the influence of rainfall: The Slide gave a Safety Factor of 1,162 before the influence of precipitation, that is, when the water table was 30 m (Fig. 2).

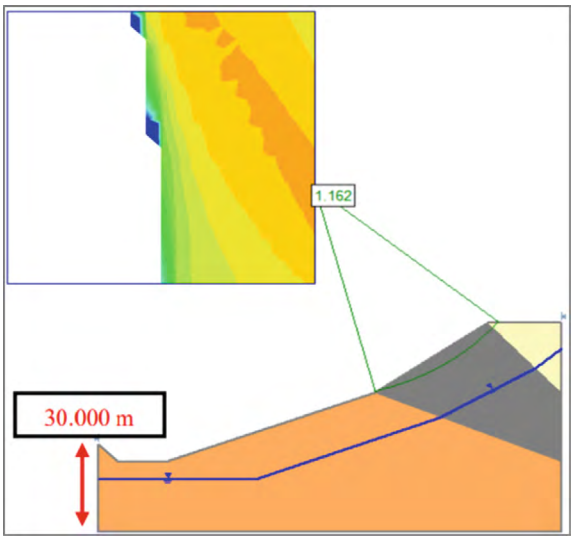


Fig. 2. First F.S

2. After the influence of rainfall: The Slide gave a Safety Factor of 1,112 after considering the influence of rainfall, that is, when the water table was 30,001 m (Fig. 3).

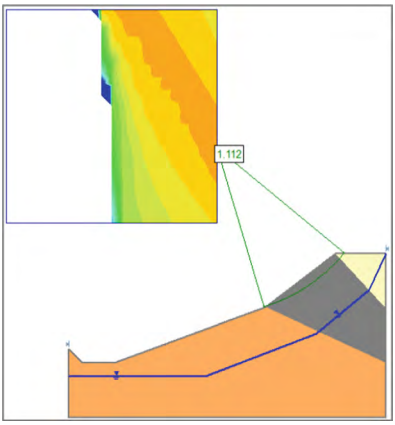


Fig. 3. Second F.S

3. Saturated nappa: To demonstrate the importance of rainfall in the stability of a slope, a case was taken where the slope was completely saturated, and the result of the F.S was 0.626. (Fig. 4)

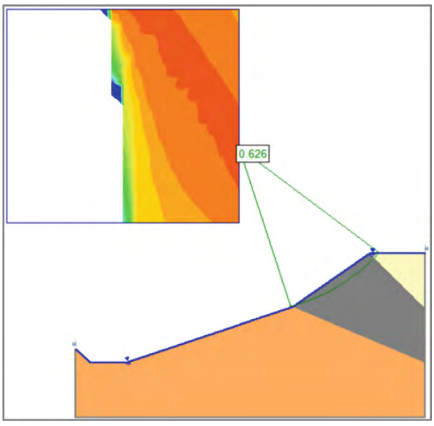


Fig. 4. Third F.S

PoF Calculation. The first step was the selection of the parameters required for the desired calculation. For our research, the cohesion and internal friction angle of the main types of rocks identified in the previous objectives were defined as parameters. For this, 10 samples of each type of rock were applied and the mean and standard deviation of each parameter and by rock type were calculated. The Probability of Failure calculation was performed in 2 scenarios:

1. With the influence of rainfall: The result, for the case study proposed with a water table height of 30,001. (Fig. 5). The probability of failure calculated for the case study

presented was 29.604%, which shows that the slope is in a medium-high probability of sliding, this is related to its F.S. calculated.

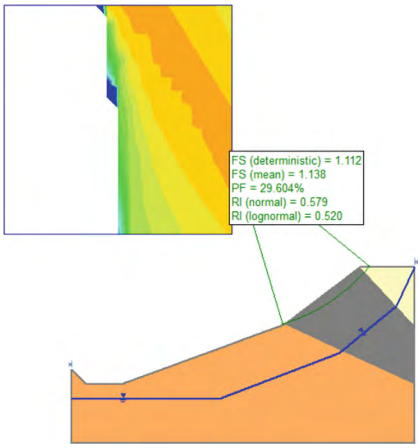


Fig. 5. First PoF

2. Without the influence of precipitation. In order to check the relationship of rainfall with the probability of failure of the case, the same process was carried out, but with the initial conditions, that is, with the water table at 30,000 m. (Fig. 6). The probability of failure calculated for the height of 30,000 groupers was 18,561%

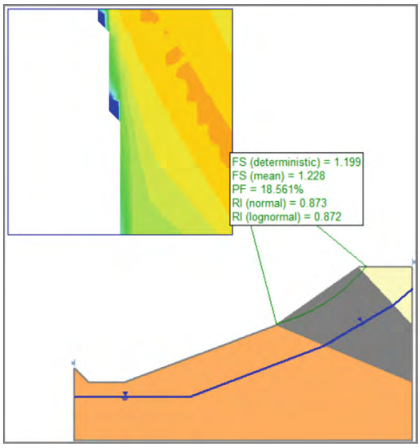


Fig. 6. Second PoF

5 Discussion

By reviewing different studies on the probability of failure together with a mathematical method, differences and similarities were found with respect to the results. For the evaluation of the safety factor, the Janbú method and the Slide software were implemented to

calculate the safety factor in the most favorable and unfavorable conditions, the results were 1.4 and 0.72, specifically, these results are similar to the case [14] where the Limit Equilibrium method was used to determine the FS in a shallow mine, the F.S. The most favorable was 1.5, while the least favorable gave a result of 0.79. In another investigation [15] performed the safety factor analysis using the limit equilibrium method to calculate the FS in a dry open pit, the result was 1.83, while, in the research work, the FS is 1.49 without count on the influence of rainfall. To calculate the probability of failure, the MonteCarlo probabilistic model was implemented with the Slide program, setting as parameters the cohesion and angle of internal friction of the rocks to be evaluated and the water table as a coefficient, while for the research work of Zhao (2016) the parameters they used were the following: groundwater level, the residual friction angle of the rock surface, the roughness coefficient of the joint and the compressive strength of the joint, both investigations use information geomechanics of the area. Additionally, Fernández (2018) used the same probabilistic model to calculate the different random data of the friction angle and cohesion, as well as their standard measurements and distributions.

While in Obregón's research (2019) the MonteCarlo probabilistic model was implemented in the same way to calculate the probability of failure, its result was 12, while, in this research work, the result of the probability of failure was 33%, the difference is due to the fact that in this investigation the factor of rainfall and different dimensions was taken into account.

6 Results

Two results were obtained with respect to the slope influenced by rainfall. The safety factor gave a result of 1,112 being considered low, this agrees with the probability of failure, which is 29,604%, concluding that the slope is prone to landslide.

7 Conclusions

It is concluded that for the calculation of the safety factor there are different factors that influence its value, in this investigation the F.S. static, where forces are not considered seismic and the F.S. pseudostatic where horizontal and vertical seismic forces are considered.

For this research, the following seismic forces were taken into account: horizontal 0.134 and vertical 0.2, because Peru is in a seismic zone, the F.S without considering the influence of rainfall gave a result of 1.162, while the F.S. If you consider rainfall, it decreased to 1,112.

In addition, it was observed that the water table of the pit to be evaluated increased by 0.001 m due to the rainfall that occurred for more than 10 years, this change in height caused the probability of failure to increase by 11%, this probability was found according to the geomechanical and physical parameters of the evaluated massifs.

Finally, it was found that rainfall influences the stability of slopes, so we must consider the volume of the groundwater table in the design of the pit, since this will increase over the years.

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Human-Machine Cooperation and Optimizing Strategies for Cyberspace OSINT Analysis

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Abstract. Cyberspace open-source intelligence is a subset of open-source intelligence that mainly pay attention to the information that reflects tactics, technology, procedures, behaviors, events, and other elements which are valuable for cyberspace defenders to gain an advantage in finding out what is happening, why is it happening and how to deal with troubles concerning cyberspace environments. As the scale and complexity of cyberspace continue to rise, nobody could process that increasing amount of data in time. To extract important information from fragments of observing results, it is necessary to strengthen human-machine cooperation in the intelligence domain for better accuracy, insight, and efficiency. From the viewpoint of space dimension, time dimension, and layer model of intelligence-organization, the desired relationship between human and machine and their respective duties are investigated by model-based methodology research, while corresponding suggestions are purposed for better analysis accuracy, insight, and efficiency in the future.

Keywords: Human-machine teaming · Cyberspace OSINT · Cooperative research · Optimizing strategies

1 Introduction

As cyberspace has been regarded as the main driven force for the economy, society, and culture development in the century, potential attacks, risks, and threats of cyberspace grew severe and became a key factor in national security in challenging environments. The borderless, dynamic, high dimensional, and virtual natures of cyberspace have brought the unprecedented hard situation in which the importance of appropriate, efficient, and timely intelligence is well recognized and intensively pursued. Cyberspace open-source intelligence (Cyberspace OSINT) is a subset of open-source intelligence (OSINT) that mainly pay attention to the information that reflects tactics, technology, procedures, behaviors, events, and all other elements which are valuable for cyberspace defenders to gain an advantage in finding out what is happening, why is it happening and how to deal with troubles with respect to cyberspace environments [1, 2].

Cyberspace is an important source of open-source intelligence, and cyberspace security is a typical application field of OSINT practice. Similar to conflicts that happened in

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 634–642, 2022.
https://doi.org/10.1007/978-3-030-85540-6_80

real space, cyberspace confrontation is also extremely dependent on correct and timely intelligence. The attacker needs to handle comprehensive information of the target to launch an attack accurately and efficiently, while the defenders rely more on the gathering and analysis of intelligence to tackle the uncertainties originated by the randomness of attacking timing, place, and tactics. Cyberspace security OSINT realizes the timely identification and effective use of new categories and methods of risks through active tracking and analysis of the characteristics, methods, and patterns of cybersecurity threats from massive data.

However, nowadays possible sources of OSINT are dispersed through social networks, blogs, twitters, news websites, forums and many other places. The number, quantity of content and updating frequency of such sources keep increasing in the big data era, which brings unprecedented difficulty for intelligence analysts to complete their "observing-orienting-analyzing-exporting" workflow. Great challenges and problems arise while the complexities grow beyond their control.

The rest of the content is organized as four sections. By delving into the essence of cyberspace intelligence, the theory and methodology of intelligence recognition, aggregation, fusion and decision-making is investigated, especially the target, goal and techniques for OSINT research under cyberspace security domain are discussed. In the next section, the human-machine teaming model is probed into three respective dimensions such as spatial, temporal and layered view. In the fourth section a quadrant of different roles and responsibilities human or machine should take for better cyberspace intelligence performance is depicted and discussed briefly. The last section concludes the work.

2 Backgrounds of Cyberspace OSINT Research

2.1 OSINT Used as Cyberspace Model

Intelligence refers to the primordial or reactivation of knowledge or facts that are generated, transmitted, and processed to solve specific problems by using certain media or carriers while transcending space and time to be reached by specific users. According to Gartner's definition, cybersecurity intelligence is a kind of evidence-based judgment and forecast, and a dynamically updated knowledge carrier that can contain vulnerabilities, threats, characteristics, lists, attributes, resolution suggestions, individuals, and organizations Early warning notices, vulnerability notices, threat notices, etc. which can be obtained from security organizations and institutions [3].

Informatization of security threat information is an inevitable choice for cyberspace defense to evolve from a loop-based approach in the past to a threat-based approach under new threat forms and risk scenarios [4]. The three subjects that are most closely related to cybersecurity threat intelligence are people, process, and technology. Security threat intelligence can serve situational awareness, early warning, and emergency response. It is establishing the cornerstone of a new generation of defense systems together with ideas such as big data security analysis, kill chain-breaking etc. Through cyberspace OSINT, defenders can not only understand "what has happened" "What is happening" and "what is going to happen" can also be inferred with a high confidence.

2.2 OSINT Used as Value Carrier

The essence of intelligence is to reduce the uncertainty of information conflicts in its contents. In cyberspace warfare, the meaning of intelligence has evolved into any useful information that is beneficial to the defender. The content of this intelligence may be extremely rich or concise: can be machine-readable structured data or a complex report for decision-making. In most cases, cyberspace OSINT will be helpful to defend the organization and its assets. The implementation of defensive behaviors has positive guiding significance and is a powerful weapon in the cyberspace defender's toolbox.

Security OSINT responds to complex threats with collective intelligence which builds a solid line of defense with foresight. The time window before the attackers finally reaches the essential assets of the corporation is short but precious, that every second counts for the potential damage that the attacker will deal with the system. Effective OSINT could be used to give early-warnings to the victim in advance to the extent the window time frame for longer preparation and arrangements accordingly.

2.3 OSINT Used as Knowledge Engineering

Traditional ways of processing and generating cyberspace intelligence are largely based on manpower as orienting, gathering, analyzing, and predicting such information requires both human professional knowledge and experience. The rapid popularization of the Internet and the everlasting development of communication technology have brought new opportunities for the revival and innovation of the OSINT paradigm.

Similar to the richness, hierarchy, and interdependence of the elements of the natural ecological environment, the producers, transmitters, consumers, and regulators of security threat intelligence, as well as the information environment and boundaries on which these intelligence subjects depend, all constitute the ecology of security threat intelligence cycle. Through the convergence of numerous individual knowledge in the ecosystem, as well as the macro and micro regulation of the demand-supply counterparts, human intelligence and machine intelligence cooperate, complement, and develop with each other to form a type of hybrid intelligence. More complex algorithms, more sophisticated tools, more comprehensive data, and closer human-machine collaboration will greatly promote the quantity, quality, and efficiency of intelligence mining in the cyberspace OSINT process; thus people would be supported better by intelligence products and work as a closer collaboration.

3 Human-Machine Teaming Models in OSINT Research

The comprehensiveness and complexity of cyberspace security issues repetitively prove that cyberspace defense should be examined and designed from a systematic perspective. People, technology, and strategy are the three indispensable elements in the system model. Cyberspace security system is a dynamic and continuous process that requires frequent investigation and reflection. The ultimate goal of cyberspace OSINT research is to discover network risks, identify network threats, and protect network security, which is also closely related to people, technology, and strategies.

Human-machine teaming technology to provide the OSINT analyst force better scalability, capacity, flexibility, and collaboration. Efforts to advance computing development and training initiatives will give analysts the time and data they need to become more precise and effective in their research on cyberspace problems [5]. From the viewpoint of space dimension, time dimension, and hierarchy of intelligence organization, the desired relationship between human and machine is investigated within the cyberspace security domain.

3.1 Spatial Model for Threat Introducing Elements

As a type of artificial space, cyberspace has postmodern characteristics that are different from traditional spaces such as openness, de-boundary, centerless, and interweaving facades of virtual and real, which brings randomness and uncertainty that are difficult for analysts to accurately calculate, reason, and predict. The physical and logical entities of cyberspace include computers, communication network systems, information systems, embedded processors, controllers, and the data carried or stored by them. The spatial model of OSINT research in cyberspace focuses on the three important security parties of "people, vulnerability, and connection", which can reflect the essential common ground of most security issues as shown in Fig. 1.

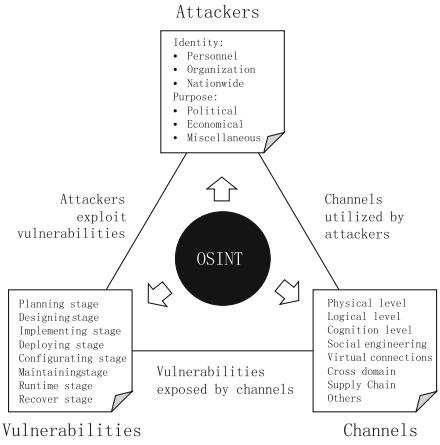


Fig. 1. Spatial model of cybersecurity OSINT research

The spatial model depicts the cause and effects of intelligence in the cyberspace security lifecycle using three separate components. Attackers may include script kiddies, medium-sized organizations, or large national forces, and they have different motivations such as politics, economy, and culture. "Vulnerability unavoidable" refers to the root cause of security that is originated from faults, bugs, and vulnerabilities of systems themselves, which is inevitable and cannot be substantially eradicated. "Channel ubiquitous" is the main construction target for cyberspace architects. The power of the internet is directly related to the number of nodes and links it has. The more system

that it connects to and the wider area it covers, it will be viewed as more useful. However, that convenience is a double-edged sword, it benefits the user but also benefits the attacker. Bad people could start the attack at any time, from anywhere, to any target the network reaches. When connection, data, and services are everywhere, the danger is also everywhere to be found.

3.2 Temporal Model for Attacker-Defender Timing Characterization

The temporal model incorporates the famous attack-chain paradigm and extends it for human-machine mutual intelligence analysis purposes. When viewed from the time-phased dimensions within the context of cyberspace conflict, one can find the gaming feature of loop interlocking is disclosed. The essence of cyberspace security is a multi-party contest, and the essence of a multi-part contest is the technology balance between attackers and defenders, namely the gaming of the kill chain [6]. Seven steps of espionage, weaponize, load, utilize, install, command, and control are used to characterize the kill chain's preparation phase, invading phase, and payoff phase. As opposed to the killing chain, security practitioners also establish defending chain to stop the attackers from gaining any desired progress. Defending chain is constituted by six interdependent steps of monitor, protect, detect, respond, recover and verify, see Fig. 2.

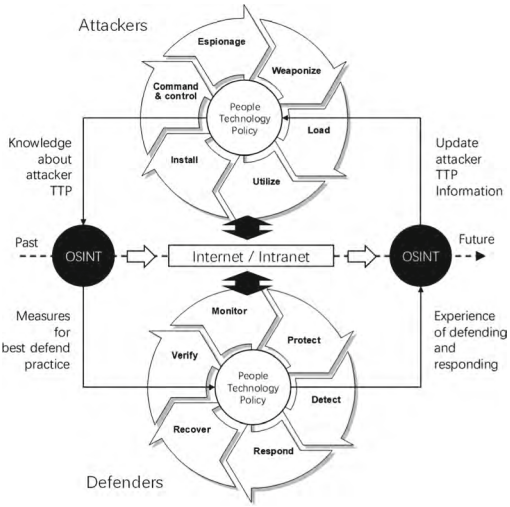


Fig. 2. Temporal model of cybersecurity OSINT research

The contact interface of the two chains is the Internet or Intranet that certain data, resources, or services reside on. With the help of OSINT received before attackers make any effective more, defenders could gain knowledge and insight of attacker TTP to deploy corresponding measures for better guarding its assets against intrusion. And after the attacker moves, all traces, paths, tools, and tactics that attackers used will be recorded and transformed to standard form for OSINT update. The experience during defending

and responding gained this way will as well be used for other corporations in similar situations to achieve OSINT knowledge-sharing purposes.

3.3 Layered Model for Categorizing Semantic Granularity

The last model attempts to stratify different abstractions of intelligence according to their content expression and assign each of the layers with distinctive semantic expression and information exchange standards. By the synthesis of such models, specific roles for human-machine would be recognized from a higher level.

Table 1. The layered model of cyberspace OSINT level

Lvl	Risk name	Question answered	From	To	Machine-readable
7	Risk prediction	How risks will develop and divert?	SIEM	Experts	Seldom
6	Risk trend	Why did risk happen?	SIEM	Experts	Seldom
5	Security event statistics	How many times did events occur?	SOC	SIEM	Partially
4	Risk warning	What type of risks?	Device	SOC	Partially
3	Risk Event	Did a risk happen?	Device	SOC	Yes
2	Multiple indications	Which ones are unusual?	Device	Device	Yes
1	Single indication	Which one is unusual?	Sensor	Device	Yes

Table 1 gives the 7 levels and their meanings of general security risks. Different rows represent the level of detail of the security risk while SIEM stands for Security Information and Event Management, and SOC stands for Security Operation Center. The lower the level of data, the richer the details become, and they are more machine-readable for their well-organized data structure; on the opposite, the higher the level of data indicate more complex abstraction of risk that are easier to comprehend by human. Although users can get advice on actions and prepare countermeasures from high-level risk information, these contents are often incomprehensible to the machine.

4 Optimizing Strategies of Teaming OSINT Research

4.1 The Four-Quadrant View

It is obvious that in the cyberspace OSINT research scope the relationship between human-machine is made even complex by the exponentially increasing amount of data and their haste updating frequency. Focus on optimizing cyberspace intelligence generation, sharing, and utilization, the basic process flow of OSINT is studied and extended

for dealing with even complex cyberspace security problems. Four different domains of value-adding strategies with the help of AI for improving human-machine cooperation are separately investigated in detail. The four quadrants are aligned by whether a certain field is prone to creative thinking and experience-based intuition, thus less work should be done by machine for their effortless in dealing with such problems.

The Machine First Quadrant. Counter-intuitively, solving difficult problems for humans requires very little computing power for the machine, while realizing human unconscious skills and perception requires great machine computing power. This paradox reflects the limitations of the Turing machine in its distinctive capabilities. It shows that the memory and computing power of computers are beyond the reach of human beings, and human intuitions and insights are also beyond the reach of computers. The collection of cyberspace security intelligence is a kind of behavior activity that can be highly computerized. According to actual needs, OpenIOC [7], STIX [8], and other standardized open-source intelligence format are converted for use.

The Human-Aided Machine Quadrant. Information fusion is the process of integrating and refining the original information from multiple sources obtained by crawlers and pre-processing into high-availability information related to analysts, subject content, or application scenarios. Since this process involves operations such as high-level semantics of intelligence, applications in different scenarios, and resolution of differences, people must participate as auxiliary elements to improve the process and accuracy. Due to the openness of open source threat intelligence sources, the intelligence information obtained by mining tools also has multi-source heterogeneity, which will hinder the storage and sharing of threat intelligence, and may also cause false negatives and false positives when applied to actual scene detection. In practical applications, it is generally necessary to integrate multi-source heterogeneous open source threat intelligence information and apply suitable control actions to improve the quality of open-source threat intelligence. Open source threat intelligence quality and credibility evaluation methods mainly include qualitative evaluation, quantitative indicators, and graph mining methods, etc.

The Machine-Aided Human Quadrant. After completing the integration of intelligence and the reorganization of data, the human analyst now enters the stage of in-depth intelligence mining. With disruptive artificial intelligence, cutting-edge data analysis, and unlimited cloud computing capabilities, OSINT analysts can quickly obtain, integrate, utilize, and visualize high-quality data in all information ranges. Comprehensive use of kill chain model, diamond model, or heterogeneous information network energy model, combined with existing open-source threat intelligence and real-time traffic data in different application scenarios, would conduct in-depth correlation, collision, and analysis operations on threat intelligence to discover potential aggressive behavior. In the human-machine relationship at this stage, the advantage of the machine is to establish a model that is considered normal based on historical data or training data including network traffic, host behavior, user operations, etc.

The Human First Quadrant. The research, judgment, and prediction of major trends in the traditional advantage of mankind. An intelligence analyst who has proficiency in

utilizing artificial intelligence and OSINT skills understands the domain knowledge and historical background, review the causes and steps of the attack, and thus can quickly understand what is happening and what is about to happen in the next step to make the right decision and expectation. Although they are unable to capture, organize, correlate and understand massive intelligence and data streams beyond their brain capacity, analysts usually have keen intuition, curiosity about details, and a premonition of possible impacts to understand attacks in depth. However, it is still the mission and responsibility of mankind to conduct comprehensive research and judgment on all incidents and make final determinations for emergency responding.

5 Conclusion

Cyberspace intelligence is a typical field of joint application of data science and man-machine coordination. Human experts use artificial intelligence tools, formal modeling, and computing capabilities to monitor and predict destructive events, and make judgments on the unknown attribute variables of the research object based on the known attribute variables, conducts an in-depth analysis of machine-generated insights, studies, and judges the possibility of potential dangers. The next step for analysts is to identify the opportunities and challenges of human-machine collaborative OSINT analysis, recognize and strengthen existing research work, and realize better intelligence processing performance based on continuously improved computing power, algorithms, and high-quality data.

Acknowledgments. This work is partially supported by Science and Technology Fund of Sichuan Province under Grant 2017GZDZX0002, 2019JDJQ0058 and 2020JDTD0034.

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Modern WebQuest Models: Applications in Education

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Abstract. The paper presents the modeling of an educational WebQuest as a component of didactic information technology with special attention to the criteria and levels of success in its applications. A WebQuest is a problem-oriented task that requires the use of information resources available online. The relevance of using a WebQuest in the educational process is connected with the implementation of the competence-based approach, the main requirement of which is effective knowledge and skills management. The authors have developed primary mathematical models of a WebQuest based on set theory. Sample applications of these modern models in education are provided.

Keywords: WebQuest · Models · Education · Information technology

1 Introduction

One of the most promising didactic technologies is the so-called educational quest, which combines a set of problem tasks with elements of a role-playing game [1]. The application of emerging technologies, namely the internet-based information technologies, leads to the transformation of an educational quest into a WebQuest, defined by Bernie Dodge as "an inquiry-oriented activity in which some or all of the information that learners interact with comes from resources on the internet, optionally supplemented with videoconferencing" [2]. In other words, a WebQuest is a problem-oriented task that requires the use of information resources available online.

An essential feature of WebQuests is that the information presented in its process for independent or group work of students is provided on various websites but students still work in one information space, due to active hyperlinks. For example, students are given the task to collect materials concerning this or that particular topic online and to solve a certain problem using these materials. The weblinks to some of the sources are given by teachers, while other sources can be found by students on their own with the help of search engines, such as Google. Having completed their WebQuest, students can submit their own web pages on its topic, or some other creative work presented in electronic, printed, handwritten or oral form.

The relevance of using a WebQuest in the modern educational process is connected with the implementation of the competence-based approach, the main requirement of which is effective knowledge and skills management. In this connection, the WebQuest

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 643–650, 2022.
https://doi.org/10.1007/978-3-030-85540-6_81

technology has such advantages as the motivation of students for studying new material, the organization of work as a targeted research, the activation of independent individual or group activities of students managed by themselves. This emerging educational technology provides an opportunity to fully implement the clarity, multimedia support and interactivity of training.

It needs to be noted, however, that the potential of the WebQuest technology is still not fully used due to the insufficient development of the scientific, theoretical and methodological prerequisites for its application. In its attempt to increase the efficiency of using this modern competence-based method and technology, this research focuses on the following question: what should the conceptual and mathematical models of a WebQuest be so that they could serve as a basis for designing a competence-based educational process? The aim of the research is to develop primary mathematical models of an educational WebQuest. The key objective of the research is to identify the criteria and levels of using WebQuests in the educational process. The research object is the application of WebQuests in the educational process, while the research subject is the models, criteria and levels of success in the educational WebQuest applications.

2 Methods

The methodological foundations of the research are a systematic approach (that proclaims an inextricable link between the tasks of using a WebQuest and the tasks of the educational process as a whole), a competence-based approach (that considers a WebQuest as a mechanism for the development of students' competences and personal and professional qualities rather than just knowledge and skills), a person-centered approach (that proclaims the need to vary the educational and creative activity of students, since they are central for the educational process), a qualimetric approach (that proclaims the need for a multi-criteria assessment of the WebQuest efficiency), a process approach (that considers a pedagogical technology as a procedural model of activity, which is a systematic set of actions), and a probabilistic-statistical approach (that considers the use of didactic methods and technologies as a stochastic process).

The research methods used for the purposes of the research were the analysis of scientific literature and advanced experience of informatization of education, modeling, qualimetry methods, method of expert assessments, methods of probability theory and mathematical statistics, methods of set theory, and methods of mathematical theory of limits. When identifying the criteria and levels of success in the application of the WebQuest in the educational process, the authors took into account the fact that it is not the only competence-oriented teaching method – moreover, its efficiency increases when combined with other methods.

3 Results and Discussion

Primary mathematical models of a WebQuest should be based on set theory. Let Z be the set of tasks corresponding to the specified technology (respectively, the cardinality of such a set is the number of tasks z), F_i be the set of websites (internet sources) required to complete the i-th task ($i = 1 \ldots z$), D_i be the set of elements of knowledge and skills

required to complete the i-th task ($i = 1 \ldots z$). Then the total set of websites required to complete all tasks is

$$\varphi = \bigcup_{i=1}^{z} F_i. \tag{1}$$

The symbol U here denotes the union of sets.

Accordingly, the set of required elements of knowledge and skills is

$$\partial = \bigcup_{i=1}^{z} D_i. \tag{2}$$

The model of a separate WebQuest, taking into account both the process (execution) and the result, is the following tuple:

$$WebQ = \left\{ \Pr\ F\ f\ D\ d\ K\ S\ L^{/}\ L^{//}\ L^{///} \right\}. \tag{3}$$

Here Pr is the task statement (problem), F is the set of websites used, f is the set of information elements selected from the websites, D is the set of knowledge and skills required to complete the elements, d is the set of knowledge and skills acquired (due to the implementation), K is the set of competences corresponding to knowledge and skills from the set $D \cup d$, $L^{/}$ is the set of correspondence links between knowledge (skills) from the set $D \cup d$ and competences from the set K, S is the set of information elements of the result, $L^{//}$ is the set of internal correspondence links between information elements of the result, $L^{///}$ is the set of correspondence links between information elements of the result and the set f.

Let us provide a real-life example of the successful completion of a task following the WebQuest technology: finding semantic analogues to the Russian proverb literally translated into English as "With seven nannies a child is without an eye" (cf "Too many cooks spoil the broth") used by other peoples. Doing this task, the student "downloaded" proverbs of different peoples from open access websites, analyzed then and identified particularly the Japanese proverb "When there are many captains, the ship hits the reefs", the Tatar proverb "When there are many shepherds, the herd dies," and the German proverb "Many cooks spoil the porridge". In this case, the information elements and connections between them are as follows: the justification of the relevance of the search for common elements of cultures of different peoples (proverbs, fairy tales, etc.), the identified proverbs, the clarification of their meaning, the self-assessment of work results, the presentation created in Microsoft Power Point format, while the correspondence links are in the proverbs selected on websites and in the progress report.

If two different students perform the same WebQuest task individually (not in the same team), then the degree of difference is determined both by the difference in the process and by the difference in the result. The phase distance (degree of difference) is described by the following formula:

$$\Omega = \sqrt{\sum_{i=1}^{m} \left(Q_i^{//} - Q_i^{/} \right)^2 + \sum_{i=1}^{k} \left(q_i^{//} - q_i^{/} \right)^2}. \tag{4}$$

In this formula, m is the number of information indicators (parameters) of the performance, k is the number of information indicators of the result, $Q_i^{//}$ is the numerical value of the i-th information indicator of the second student's performance, $Q_i^{/}$ is the numerical value of the i-th information indicator of the first student's performance, $q_i^{//}$ is the numerical value of the i-th informational attribute of the second student's result, $q_i^{//}$ is the numerical value of the i-th informational attribute of the first student's result.

Let us consider the criteria for the success of a separate WebQuest for an individual student. The first criterion is the power of the set d, the second criterion is the number of competencies from the set K that have been developed (thanks to completing the WebQuest), the third indicator is the completeness and quality of performance (according to expert estimates), the fourth parameter is the degree of independence of implementation. The relevance of the first two criteria is due to the fact that the competence-based approach orients the educational process not toward the content, but toward the result (which is the formation of competences in the unity of knowledge, skills, motives and personal experience of activity). The fifth criterion is the information saturation of the process and results of execution (having an integrative nature):

$$\mu = \sqrt{card(F) \cdot card(D)} \cdot card(f) \cdot card(S) \cdot card\left(L^{//}\right) \cdot card\left(L^{///}\right), \tag{5}$$

where *card* is the cardinality of the set (this calculation model is very simplified).

If the rating method of assessment is adopted in the system of pedagogical control, then the success of using WebQuests for a student is

$$\rho = \beta\left(\overrightarrow{R}\right), \overrightarrow{R} = \left\{R_1\ R_2\ \ldots\ R_n\right\}, \tag{6}$$

where *Ri* is the level (on a 100-point scale) of completing the i-th task (WebQuest), n is the number of completed tasks, β is some function. The simplest calculation model is

$$\rho = \sum_{i=1}^{n} (w_i \cdot R_i), \tag{7}$$

where w_i is the weighting factor of the i-th WebQuest. The recommended model for calculating the rating for completing a WebQuest is

$$R = R^{/} \cdot R^{//}, \tag{8}$$

where the arguments in the formula are, respectively, the completeness and quality of performance (from 0 to 1.0, but may be more than 1.0 in case of overfulfillment) and the degree of independence of performance (from 0 to 1.0). The methodology for assessing the degree of independence is developed and presented in [3].

The analysis of models and criteria allowed the authors to identify and characterize the following seven levels of success in the use of WebQuests for an individual student: 1) lowest, with a low level of student's success in completing most of the WebQuest tasks: doing such tasks hardly affects the development of competences, as well as personal and professional qualities of the student; 2) low, with a proper level of success in completing a certain proportion of WebQuest tasks: in comparison with the previous level,

there is a higher efficiency of managing the existing knowledge and skills to complete tasks, but doing problem-oriented tasks still has little effect on the student's social and professional competence in general and the student's knowledge and skills in particular; 3) average, with a proper (in some cases even high) level of success in completing most of the WebQuest tasks: while doing problem-oriented tasks, the student acquires new knowledge and skills, but their volume is small in comparison with the volume of those already possessed by the student, and the level of readiness to work in a team is low; 4) proper ("above average"), with sufficient success in doing problem-oriented tasks (using information technology) and a conscientious attitude towards them: the use of interactive learning technologies is becoming a systemic mechanism (a significant factor) for the development of competences, as well as personal and professional qualities, in general, and the acquisition of new knowledge and skills, in particular; the student is ready to work in a team, but such work does not bring a synergistic effect; 5) high, with a high level of doing the WebQuest tasks, an active and positive attitude towards the use of interactive learning technologies, educational and creative activities on the implementation of WebQuest tasks included in the general orientation of the student's educational activity as a powerful factor in his or her personal and professional development: not only the proper level of reflection (introspection of activity and its results), but also a high level of independence and the proper level of creativity when performing tasks is observed; besides, there is a continuity in the execution of WebQuests, which consists, first of all, in the use of the results of the previous WebQuests, as well as in the active use of the knowledge and skills acquired (thanks to the completion of WebQuests); 6) very high, with a full disclosure of the creative and didactic potential of the WebQuest technology: WebQuest tasks are performed and presented at a very high and even the highest level, they are a powerful factor in the development of both professional and general competences of the student (discipline, communicative competence, the ability to work in a team, etc.); formalized (i.e. computerized) analysis of both the process and the results of doing the tasks is possible due to their being clearly structured, which also provides opportunities for the construction of a cognitive model of communication (in the form of a graph) between information elements; by means of problem-oriented tasks, the student not only develops competences (acquires new knowledge and skills) but also discovers new subject areas for his or her interests; 7) highest, when the student's experience of educational and creative activity becomes patterned, the results of performing a WebQuest are suitable for their use as components of electronic educational resources, and the student "sets the level" of work and helps other students to increase the effectiveness of educational and creative activities when working in a team. With an increase in the level, the role of a WebQuest in the personal and professional development of the student (in the formation of his or her social and professional competence) also increases.

The authors have also highlighted and characterized the levels of success of using the WebQuest for a group of students: 1) lowest, with a low level of application of WebQuest technology by the majority of students; 2) low, with WebQuests performed at a proper or high level by a significant proportion of students, but with poor implementation of the person-centered approach (i.e. there is little individualization and differentiation of learning): the competence-based approach is implemented to a greater extent than the person-centered one; 3) average, with a proper or high level of WebQuests (more

precisely, the success of using WebQuest technologies) for a significant proportion of students; there are attempts to differentiate and individualize training, but there are no proper relationships with other educational methods and technologies of training; at this level, however, the educational environment takes into account the positive and negative experience of using interactive learning technologies, strives to repeat successes and avoids previous mistakes; 4) proper ("above average"), with a decrease in the number of students with lowest, low and average levels and an increase in the number of students with proper, high, very high and highest levels of success in using WebQuests (as compared to the previous level); at this level, the use of WebQuest technology becomes streamlined, indicating the technological maturity of the educational environment; 5) high, with the use of WebQuest technology rationally combined with the use of other didactic methods, techniques and technologies, which determines its high efficiency; 6) very high, when the use of interactive technologies becomes a mechanism for individualization and differentiation (i.e. the implementation of a person-centered approach); at the same time, there is also a team execution of WebQuests, effective from a didactic point of view (contributing to the development of students' communicative competence and willingness to work in a team); 7) highest, when the experience of using WebQuests becomes patterned; the authority and competitiveness of the educational environment as a leader in the use of competence-oriented didactic methods, techniques and technologies increases. With an increase in the level, the individualization and differentiation of the educational process (the implementation of a person-centered approach) increase as well.

For a group of students, the success of the WebQuest technology application is calculated in the following way:

$$\alpha = \frac{1{,}2 \cdot W^{/} + W^{//} + 0{,}8 \cdot W^{///} + 0{,}6 \cdot W^{////} + \sum_{j=1}^{W^{/////}} 0{,}4^{j} + \sum_{j=1}^{W^{//////}} 0{,}2^{j}}{W}, \qquad (9)$$
$$W = W^{/} + W^{//} + W^{///} + W^{////} + W^{/////} + W^{//////} + W^{///////}.$$

Here W is the total number of students, while $W^{/}$, $W^{//}$, $W^{///}$, $W^{////}$, $W^{/////}$, $W^{//////}$ and $W^{///////}$ are, accordingly, the number of students for whom the application of the WebQuest technology took place at the highest, very high, high, proper (above average), average, low and lowest levels. In the presented formula, the first coefficient is higher than one, since students who use the WebQuest at the highest level are guides for the rest (especially when working in a team); the results of their educational and creative activities are applicable to replenish information and methodological support of the educational process (electronic educational resources). In addition, this indicator was formed in accordance with a methodology based on the mathematical theory of limits in order to limit the role of students with low levels of success (this methodology is presented in [3]).

More specific criteria for the success of the WebQuest technology application by a group of students are the proportion of students with the lowest levels of success and the proportion of students with the highest levels of success. Accordingly, there is a "useful" criterion, which is formulated as follows:

$$\beta = \frac{W^{/} + W^{//} + W^{///}}{W}. \qquad (10)$$

A harmful criterion (where a decrease in the numerical value reflects an improvement in the situation), in its turn, is expressed as

$$\chi = \frac{W^{//////} + W^{///////}}{W}. \tag{11}$$

These criteria (as the integrative criterion α) reflect the level of organization of the educational process (the quality of education, it can be said without exaggeration), namely, the aspect of how well competence-based methods and educational technologies are applied. The situation is considered favorable if $\beta \geq 0.15$ and $\chi \leq 0.1$ or $\alpha \geq 0.7$. If it is possible to assess the success of the WebQuest technology applications according to a hundred-point rating scale (with ρ_i denoting the success of the WebQuest technology application by the i-th student), it is also possible to calculate one more integrative criterion based on the scree plot method: it equals r if at least r percent of students use the specified technology at a success rate of at least r each.

WebQuest technology is applicable for the development of language competence. In 2017, a survey was conducted among 79 international students studying Russian as a foreign language at Kuban State Technological University (Krasnodar, Russia). Each of these students was given a task for their independent work: to find at least ten analogs to Russian proverbs among the proverbs of other peoples of Russia and the world. The analysis showed that 11 students coped with the task at a low level, 14 at an average level, 21 at a proper level, 18 at a high level, 10 at a very high level, 5 at a higher level, and there were no students who did the task at the lowest level. WebQuest technology is also applicable for the development of students's competences in natural science. At Kuban State Technological University, the Department of Physics (responsible for teaching this science to all students of the university) conducted a study with the sample including 2083 Russian students, of whom 986 entered the university in 2018 and 1097 enrolled in 2019. The analysis showed that the success of the WebQuest application at the lowest, low, average, proper, high, very high and highest levels, was 207, 291, 414, 562, 361, 153, 95 (9.9, 13.9, 19, 8, 26.9, 17.3, 7.3, 4.5%) respectively. In addition, the students were asked whether they considered it expedient to use the WebQuest in training. The answers were distributed as follows: not desirable but obligatory (493, or 23.6%), expedient but not obligatory (711, or 34%), hard to answer (352, or 16.8%), rather inappropriate than expedient (306, or 14.6%), impractical (221, or 10%). The presence of students skeptical about the use of WebQuest technology (24.6% of the total number) is most likely explained by the fact that the competence-based approach has not fully established itself in professional education (i.e., there are echoes of the knowledge paradigm). In addition, not all students in their first year(s) of study have proper levels of information competence, and this is a prerequisite for the success of WebQuests.

The theoretical significance of the research results is that they can be a basis for further understanding of such a problem as increasing the effectiveness of students' educational and creative activities at various stages of the lifelong education system. The practical significance of the research results is that they can be used in educational monitoring systems for the assessment of students' competencies, as well as personal and professional qualities. This possibility arises from the fact that the tasks corresponding to the WebQuest technology are control and competence assessment tasks. The practical significance of the results of this research also lies in the fact that they can serve as a basis

for the design of network technologies for distance learning, whose role has dramatically increased due to COVID-19 pandemic.

4 Conclusion

A WebQuest is not the only competence-oriented pedagogical technology that should be used in the educational process (at the most diverse levels of the lifelong education system – from general education schools to postgraduate vocational education). But it is obvious that in the context of the informatization of education, this is the most effective form of using information technologies for teaching and learning purposes. The use of WebQuests should be optimally combined with the use of other teaching methods and technologies. It should also be noted that the use of WebQuest technology allows solving not only didactic, but also metrological problems, such as a comprehensive assessment of students' competences. The research prospects include the development of optimization models for using a WebQuest (taking into account the shortage of time resources), in combination with other methods and technologies.

Acknowledgments. The research was carried out with the financial support of the Kuban Science Foundation in the framework of the scientific project № FSR-HS-20.1/37.

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COVID-19 Pandemic as an Impetus for Development of 5G Networks in Bulgaria: A Case Study

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Abstract. The coronavirus pandemic and the measures to curb it persuaded humanity of the crucial importance of the telecommunications industry for the functioning of society. The need to strengthen the existing telecommunication networks and facilities and to build new ones becomes inevitable. In 2020 two of the leading telecoms in Bulgaria managed to launch 5G networks despite postponed frequency tenders. This research is a case study of the process of building 5G telecommunications networks in Bulgaria, against the background of the unfolding global COVID-19 pandemic. The author claims that COVID-19 related restrictions do not cause a significant delay in the entry of innovations on the telecommunication market in Bulgaria. Alongside with the EU Strategies and Plans, it can be perceived as an accelerator for the development of 5G networks and services.

Keywords: 5G networks · Telecommunications · Digital infrastructure · COVID-19 · Spectrum assignment

1 Introduction

The coronavirus pandemic has been testing the ability of the telecommunications industry to meet society's growing needs for interaction, work, study and entertainment from home. In line with the calls of the European Commission (European Commission 2021) and the International Telecommunication Union (International Telecommunication Union 2020a), governments and the telecommunications industry are taking steps to strengthen existing and deploy next-generation transmission networks as part of preparations for a possible new crisis of a similar nature.

The ITU emphasizes the critical importance of digital infrastructure for managing the coronavirus pandemic as well as for repairing the damages it has inflicted (International Telecommunication Union 2020b). Widening digital divide between countries is among the worst effects. The European Commission identifies the development of digital connectivity as one of the key elements for the recovery of the European economy from the pandemic. In some countries, the fight against COVID-19 has been preventing

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 651–657, 2022.
https://doi.org/10.1007/978-3-030-85540-6_82

innovative technologies from entering the telecommunications market. In other countries the pandemic is becoming an incentive to upgrade existing and build new transmission networks.

2 Research Design

This article is a case study of building 5G telecommunications networks process in Bulgaria during the global COVID-19 pandemic, against the background of the other European union member-states. The aim is to highlight the pandemic impact on the process of 5G implementation at the national and European level. The research explores the period from the emergency state in Bulgaria (13 March–13 May 2020) to the end of year 2020. The methods used in this article are a mix of descriptive and analytical techniques, such as observation, analysis of primary and secondary data, comparative case analysis. Main sources for gathering information are normative and regulatory databases at national and European level, ITU reports and documents, corporate information, websites of non-governmental and professional organizations, scientific and newspaper articles. The author claims that, in Bulgaria, not only do not COVID-19 related restrictions cause a significant delay in the entry of innovations on the telecommunication market, but also it can be perceived as an accelerator for the development of 5G networks and services.

3 Results

3.1 Telecommunications and 5G in the European Union During Pandemic

Measures against the spread of the coronavirus have an almost immediate impact on the telecommunications sector globally. Companies, involved in developing digital infrastructure, bear the brunt of the heaviest load during the lockdown, and negative financial growth is expected to unfold in 2021 (International Telecommunication Union 2020b). The initial losses are accumulated mainly by a logical reduction in roaming due to travel restrictions and bad debts.

Although in the EU region roaming tariffs have been cut back to the level of home-country usage, still the roaming revenues from people traveling beyond the EU averages 6% of an operator's total revenue. A positive effect of this crisis situation is the increased demand for corporate network services and an expansion of corporate mobile networks (also promising for 5G), leading to further revenue growth opportunities (Deloitte Netherlands 2020). Safety measures implemented in response to the COVID-19 pandemic were likely to have provided a boost to employment in the EU telecommunications sector. According to Eurostat, the number of people who were employed in telecommunications increased significantly in the second quarter of 2020. This represents a 7% increase from the first quarter of 2020 and a 21% rise when compared with the second quarter of 2019 (Table 1).

Table 1. Number of Employees (Aged 20 to 64) in EU Telecommunications Sector

2008	2019 (Q4)	2020 (Q2)
1 181 000	823 000	1 043 000

Source: Eurostat (2020).

Since the beginning of coronavirus pandemic the internet traffic increased by about 30% globally. It is expected that it will remain constant after the end of the lockdown (ITU 2020b). Although the new jobs are not evenly distributed among all EU Member States, we can assume that they will not be temporary work employment.

Fearing that the European Union will be lagging behind in digital, the European Commission calls on member states to boost investments in very high-capacity broadband connectivity infrastructure, including 5G, which is the most fundamental block of the digital transformation and an essential pillar of the recovery (European Commission 2020). The Commission's strategy on Connectivity for a European Gigabit Society sets the EU connectivity objectives: by 2025, all main socio-economic drivers (i.e. schools, hospitals, transport hubs) should have gigabit connectivity, all urban areas and major terrestrial transport paths should be connected with uninterrupted 5G coverage (European Commission 2019). As part of the EU 2016 5G Action Plan, nations committed to developing their next-generation telecommunications infrastructures. These targets included the launch of 5G services in all member states in at least one major city by the end of 2020 (European Commission 2016).

At the end of December 2020, 23 EU countries + UK (see Table 2) enjoy 5G services and in several countries, there are more than one 5G service provider.

Table 2. EU 5G Roll-Out by Countries (at the end of 2020)

Total number of EU countries with at least 1 5G service (23 + UK)	First 5G commercial service during 2020 (15)	No 5G service
Austria, Belgium, Bulgaria, Croatia, Czech Republic, Estonia, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Luxembourg, Netherlands, Poland, Romania, Slovakia, Slovenia, Spain, Sweden and the UK	Belgium, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, France, Greece, Luxembourg, Netherlands, Poland, Slovakia, Slovenia, Spain, Sweden	Cyprus, Malta, Lithuania, Portugal

Source: European 5G Observatory (2020).

The goal, set in Action Plan 2016, has been partially achieved. Countries are lagging behind in assigning 5G pioneer bands (for Europe: 700 MHz, 3.6 GHz, 26 GHz). At the end of December 2020, the most tested frequency band in Europe has been the

3.6 GHz band. The 26 GHz band portions are allocated in three countries. The 700 MHz distribution has been advancing slowly (EU 5G Observatory 2020). A greater part of the digital terrestrial radio and TV broadcasting is located in this frequency bandwidth. This type of broadcasting still has a significant influence on the European media model. Until 2030, a sub-700 MHz band (470–698 MHz) has been reserved for the needs of DTT.

In 2020, the coronavirus pandemic caused a delay or reschedule of spectrum assignment auctions in many European countries. Most of these auctions were held within the same year or in the first months of 2021.

3.2 5G in Bulgaria

Bulgaria is among the EU countries in which radio spectrum tenders for 4G and 5G, scheduled for mid-2020, have been postponed to the first quarter of 2021. However, in 2020 two of the leading mobile operators managed to launch their own 5G networks, although with very limited coverage.

As of September 2020, Vivacom's network covers the centers and adjacent parts of 27 major cities and the route of the Trakia highway ("5G Now In Bulgaria by Vivacom", 2020). The areas covered have been chosen so that the objectives set out in the EU 5G Action Plan 2016 and the EU Strategy on Connectivity for a European Gigabit Society can be met. These are the big cities and the main transport corridors (the Trakia highway is part of the Pan-European Corridor №8, which connects the Adriatic with the Black Sea). Dynamic Spectrum Sharing (DSS) technology is applied which enables the parallel use of LTE and 5G in the same frequency band.

In November, A1 Bulgaria announced the launch of its own 5G network in parts of the capital Sofia, and later in the Black Sea city of Burgas. The two telecoms promise rapid development of their new networks and the variety of support devices. The third leading mobile operator – Telenor Bulgaria, has so far announced 5G tests.

The two 5G networks in Bulgaria became a fact after overcoming the three main obstacles to the development of mobile communications in the country.

The first is the scarce radio spectrum in the attractive bands for the development of modern mobile services. Since their start in the 1990s, mobile networks in Bulgaria have operated in the 900 MHz, 1800 MHz, 2.1 GHz, 2.6 GHz bands (Communications Regulation Commission n.d.). Prior to the coronavirus crisis, mobile operators in the country had reached the limits of the allocated spectrum and urgently needed additional resources (Arnaudov 2019a).

The most favorable bands for achieving national network coverage with a minimum of investment and equipment (700 MHz and 800 MHz bands) remain occupied by the Ministry of Defense. The telecommunications companies demand the complete release of the two bands, which in combination with the frequencies in the 3.6 GHz and 26 GHz bands will provide full and dense network coverage of the country's territory. After the optimization of the digital terrestrial TV broadcasting, in June 2020 small slices (2×20 MHz) were released in 700 MHz band. Using them for the upgrade of 4G or 5G deployment is technically impossible and financially unjustified. Therefore, the Communications Regulation Commission refuses to offer them and they remain unallocated.

Following the postponement of radio spectrum auctions, in 2020 the Commission provided temporary frequencies in the 3.6 GHz band (100 MHz in total) to the country's three leading mobile operators for the development of innovative services, including 5G (Communications Regulation Commission 2020a). The first two 5G networks in the country are being developed in this range, with temporary licenses for use until tenders are held.

The second important condition for the development of the telecommunications sector in Bulgaria is the reduction of high fees for the use of radio frequency spectrum. The tariffs date back to the 1990s, when they were imposed based on the prices in large and rich markets, such as Germany and France, and they do not reflect the real situation in Bulgaria (Arnaudov 2019b). After long negotiations between mobile operators and the regulator, an over 50% decrease of tariffs was reached (Communications Regulation Commission 2020b).

The third major obstacle to the penetration of innovative technologies into the Bulgarian telecommunications market is the cumbersome and expensive administrative procedures for technological renewal. Deploying a new base station requires a permit to build a new building and takes between 6 and 24 months. Following the end of the state of emergency in 2020, legal changes have been adopted to significantly alleviate these conditions. Increased control over the activity and transmission of antennas remains in force as well (Botchevska 2020).

The way to modernize existing networks and build 5G ones seems to be cleared. The first 5G networks in Bulgaria started working under simplified administrative regime and temporary permits. They became operational between two waves of the coronavirus pandemic. During the state of emergency (13 March-13 May 2020), the key importance of high-speed and reliable connectivity for the functioning of society as a whole became quite obvious. Mobile operators report higher revenues and improved image (Miteva 2020). The authorities are aware of the need to develop digital infrastructure to prepare the country for its participation in the common European digital market and possibly for a new health crisis. The government and the regulatory body are changing their approach to the telecommunications business from strict control of the activity and imposition of restrictions towards assistance and control of the outcome.

4 Conclusion and Discussion

The coronavirus pandemic is testing the resilience of telecommunications companies globally. It also provides new opportunities for development and interaction with the authorities, for more successful management of future crises, mitigation of their consequences, ensuring the normal functioning of society in the conditions of lockdown.

In Bulgaria, this new approach of interaction leads to almost immediate results, in the form of solving long-standing disputes, long-awaited legislative and regulatory changes and technological development, for the benefit of business and consumers. Although it fails to allocate the radio frequency spectrum in time, Bulgaria manages to meet the deadlines of the European Commission for the initial launch of 5G networks. Preparations for the building of 5G began long before the mass spread of the coronavirus. It can be argued that the deployment of the pandemic has an accelerating effect on the

process, while the pan-European goals and deadlines have a disciplinary effect on its participants. The country traditionally ranks among the lasts in the annual EU Digital Economy and Society Index (DESI). In 2021, it is reasonable to expect that it may move up in the rankings by component Connectivity.

The future successful development of existing 4G LTE and new 5G networks largely depends on the balanced and timely allocation of the required radio spectrum. 700 MHz and 800 MHz band will remain blocked at least until 2023, when the replacement of Soviet era military aircraft and navigation systems of the Bulgarian Air Force with American F16 is expected. It is likely that after this date, both ranges will continue to be used for national defense purposes. It is necessary for the government and the Communications Regulation Commission to look for flexible solutions that will simultaneously ensure the protection of national interests, the development of society and the economy, compliance with the country's pan-European commitments and the decisions of the World Radiocommunication Conferences.

Acknowledgments. This research has been developed within the framework of the Programme "Young Scientists and Post Docs" of the Bulgarian Ministry of Education and Science.

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Lean Manufacturing Model for Production Management Under Design Thinking Approach to Increase Productivity of Musical Instrument SMEs

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Abstract. Currently, small- and medium-sized musical product businesses in Peru are in standstill due to low market demand. Under these conditions, venturing into a foreign market can be an option, where according to the reports of the Integrated Foreign Trade Information System (SIICEX), they received great acceptance in 36 countries amounting 497,391 US dollars, but the problem of higher productivity arises for a continuous export. Therefore, a lean manufacturing production management model needs to be developed under the design thinking approach to solve this issue. The proposed validation obtained a significant representation not only by promoting the product line but also in complying with high production standards of the different foreign countries. This study forms a research base to establish a production management model that benefits most SMEs in the 21st century.

Keywords: Design thinking · Lean manufacturing · Productivity

1 Introduction

SMEs represent 90% of the total number of active companies in Peru; SMEs are essential to support the country's economic system [1, 2]. In the musical instruments sector, companies are increasingly tempted by international markets where the monetary value of instruments can be 60% to 65% higher than in the local market. Similarly, more than 88% of companies in the music sector do not have an efficient production system where they can make the most of the available resources. In other words, companies do not invest in production management systems [1, 2].

Currently, companies manage production systems that require programming and control high standards, which is not always adequate for managing the resources available

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 658–666, 2022.
https://doi.org/10.1007/978-3-030-85540-6_83

for production. Many authors agree that, in this modern era, many companies do not have the technological development required for optimal process management. In other words, they do not have technological innovation that can enable them to meet the expected production objectives, which constitutes a disadvantage compared to other companies in the sector [1, 3].

The market is increasingly competitive, with more demanding audiences and higher quality standards and production volumes according to consumer needs. Therefore, all SMEs in the sector do not develop an adequate production management model. For these reasons, this study proposes a production management model aimed at increasing productivity in companies under the lean manufacturing model. In addition, it proposes to use the approach and concepts of design thinking for designing a production management system using the customer experience as the main factor for the design as a unit.

2 State of the Art

2.1 Lean Manufacturing in Production Management Models at SMEs

As part of our literary review on lean manufacturing, this methodology is characterized in many studies as a production system based on the organization's learning through continuous improvement [4–6]. Many authors affirm that their objective is to reduce variations and unnecessary steps in the production process—from the initial stage of the product life cycle to the ultimate distribution of the products—by removing activities that do not add value to improve performance in organizations and their environmental efficiency [4, 7]. It is a philosophy that adopts a set of tools and practices to achieve the highest quality with the lowest cost to optimize processes and improve decision-making for the company [4–8]. On the contrary, other researchers argue that, for intelligent production management and proper use of lean manufacturing, advanced information and communication systems must be applied in addition to future-oriented technology to mitigate any delay in production management [8, 9].

The authors, in general, agree that the application of lean manufacturing or lean production system has led organizations to perform at the maximum level of quality with a lower cost and orienting them to a green concept within organizations, supporting the systematic transformation of the organization [4, 5, 10]. The application of the lean manufacturing system was performed in organizations from the perspective of resources integration and improving their management [8, 9].

2.2 Design Thinking for the Production Management Model in SMEs

According to several authors, design thinking is a tool focused on fostering innovation in organizations with the aim of developing new concepts for different problems that may arise focusing on value and not volume [11, 12]. Many studies are based on an R + D + I system (research, development, and innovation), in which creativity and prototyping techniques are used in innovation groups to develop improvement proposals focused on the customer experience [3, 11]. This system focuses on the analysis of the user experience to provide ideas for improvement. The design thinking approach is oriented

toward both design process and final product, integrating different interdisciplinary teams in five phases (creation of empathy, definition of the problem, devise new solutions, prototyping, and continuous evaluation) [3, 10, 11].

Many authors point out that using a design thinking approach, it is possible to reach a greater number of ideas that can be discarded according to the requirement [3, 10]. For organizations, it is an innovative and economical approach to provide design thinking to model productivity management. For many organizations, it is a way of learning while searching for new solutions, avoiding numerous expenses in the use of traditional methods [3, 11].

3 Contribution

3.1 Base Proposed Model

This section focuses on the contribution of the proposed model and the development of a lean manufacturing model implementation to analyze and manage processes directly related to production systems in a structured manner. This should be applied under a design thinking approach for the structure of a model based on management tools necessary to induce the initiative of continuous improvement of the critical production points and profits of the company. Chart 1 focuses on the analysis presented by the previous articles, where existing management correlations are visualized in an organizational, productive, and customer-structured manner, thus allowing the exemplification of a chart that characterizes the requirements for an improved model.

In Fig. 1, shown in the previous point, we see a base model consisting of three elements: a company situational analysis, process information, and the improved proposal of a lean manufacturing model under the design thinking approach.

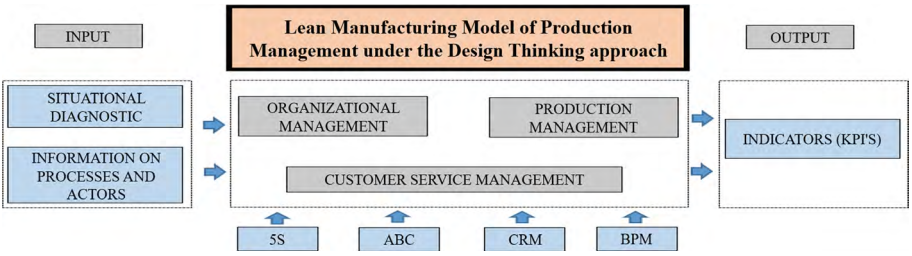


Fig. 1. Lean manufacturing model of production management under the design thinking approach

These elements are based on the analysis of the SMEs current situation and in the search for a solution to the productivity problem, resolving which may allow these companies to venture into international markets.

Each one of these is explained in detail based on the analysis of Fig. 2:

Improvement Proposal. The proposed analysis is exemplified in the simplicity of obtaining the greatest benefit of adapting a detailed structure through the following items:

- Organizational Management: It is based on the elimination of unnecessary components for standardization and continuous improvement in the organization through the 5s.
- Production Management: The second component will develop the ABC and business process management (BPM) costing tools, where production processes are restructured to achieve lower production costs, as well as optimizing the processes making them more efficient.
- Customer Service Management: This component focuses on customer satisfaction as an element to increase the profitability of the organization using the Customer Relationship Management (CRM) tool.

Key Indicators and KPI Performance Meters: In this stage, the final results of what was obtained from the implementation with the current situation are displayed and compliance with the optimal standards is verified.

3.2 Proposed Structured Model

In Fig. 2, the phases and activities to be followed for the implementation of the lean manufacturing management model are detailed.

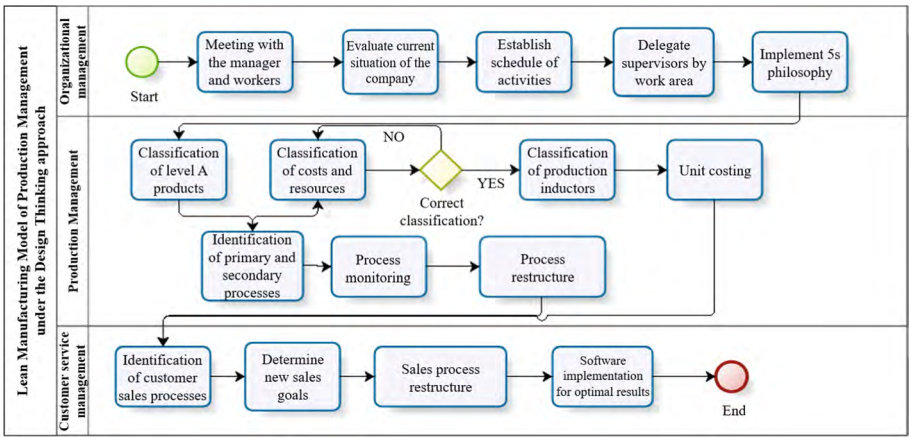


Fig. 2. Proposed model of lean manufacturing for production management under the design thinking approach

3.3 Indicators

5S Assessment Analysis Before and After Implementation. As part of the 5s methodology, audits will be conducted periodically where the performance obtained by the workers in the different links of the 5s philosophy will be evaluated.

Waste Reduction in the Production Area. This indicator refers to the percentage of waste emitted by production.

$$\%\, waste = \frac{P.M\ waste}{Target\ amount\ of\ P.M.} \times 100 \tag{1}$$

Production Indicator. It shows us the productivity index based on data such as the number of units produced, and the time of hours used for production.

$$\frac{Production}{Worked\ Hours} \tag{2}$$

Net Present Value and IRR Indicators. These are the indicators used to quantitatively determine the existence of gains or losses with the implementation of the production management model.

4 Validation

4.1 Case Study Description

The XYZ company is dedicated to the development of musical instruments, focuses on the manufacture and commercialization of wood-based percussion musical instruments under the mission that their products are representative of their local market and under the vision to structure channels for a future business associations. In view of this, it is necessary to analyze the current situation of the company through a tree of causes and consequences.

4.2 Current Situation

The current situation of the company XYZ was analyzed through a causes and consequences tree study, addressing the greatest problem in question related to profitability with productivity as this is directly related and is evidenced in more important direct causes, the synthesis in question where the main development of the problem of the Company Low productivity for an international trade is exemplified.

PHASE 1: Organizational Management. For organizational management, the use of the 5S methodology is proposed, which will provide better management in the workplace, as well as reduce manufacturing costs and generate less waste.

For the development of the 5S methodology, it is necessary to apply the five principles in the organization:

- Seiri – Sort: Classification process restructure through the implementation of colored cards (green - red) for tools in good condition and tools that are not in use or in disuse respectively.
- Seiton – Set in order: A register inventory of all machines and tools is proposed. Likewise, it is proposed to design technical sheets for each machine.

- Seiso – Shine: A cleaning process was designed for each worker to be carried out individually before and after performing their tasks, plus a cleaning record tab.
- Seiketsu – Standardize: It is proposed to delegate a person in charge for each area who ensures that the procedures in the previous points are fulfilled in the company.
- Shitsuke – Sustain: Promote continuous improvement in the organization through audits on a quarterly basis along with a 5S checklist.

PHASE 2: Production Management. Production management covers everything related to the system, processes, and activities within the companies; for this, the use of the ABC costing tool was proposed to identify and classify the manufacturing activities by assigning them a cost, and thus determine the cost based on activities that will be compared with the traditional costing of the company.

- ABC

– Product classification: Identify by means of a Pareto chart the most demanded products in the organization.
– Resource classification and costing: The costs and expenses incurred in the production process will be determined and detailed, as well as the inducers and indirect production costs will be identified.
– Unit costing: Once the necessary data has been collected, the unit cost of each product can be managed and determined through the sum of the cost of all activities destined for production between the company's production volume.

$$\frac{\sum Activities\ cost}{Production\ volume} = Unit\ cost \tag{3}$$

- Business Process Management

– Activities Identification: To integrate BPM in the company, the first step is to determine the existing manufacturing activities in the company.
– Activity monitoring: Control objectives are set for the processes according to the following attributes:
– Process duration
– Process performance according to antecedents
– Restructure of processes: bottlenecks are determined, as well as the processes and activities with the most delay in the production system, which must be evaluated and subsequently optimized.

PHASE 3: Customer Service Management. For customer service management, the CRM tool is used in order to strengthen the relationship with customers, as well as optimize the customer service and experience process.

- Objectives Identification for the new management model based on the shortcomings of the current system.

- CRM Platform - The incorporation of the Netsuit platform is proposed for better customer management and making information more accessible for the company to improve decision-making.

– Development of New Sales Procedures for new customer service systems which improve your experience with the company through good treatment and empathy.

4.3 Validation Through Risk Simulator

The @Risk Simulator is a platform that allowed us to quantify possible risk scenarios when adapting the improvement proposal made using predisposed variables that are improved through the application of the tools.

These variables allowed us to carry out possible scenarios to validate the proposal, the increase in demonstrated productivity as the lean manufacturing model under the design thinking approach directs a significant development in the described variables, which helped confirm the viability of the implementation of the proposed management system by calculating the indicators net present value (NPV) and internal rate of return on investment to be carried out from the project as shown below.

According to the average, there is still a great possibility within the range of S/.4,784.71 as the most probable NPV is S/.40,575.59. Then, there is a possibility that the project is better used.

On the contrary, the Risk Simulator also helped to calculate the internal rate of return on the project's investment, which indicates that according to the range of scenarios through the 10,000 tests carried out, from if 25% will be profitable, the project will have a 96.41% of security that the project has a positive assured IRR, which allows validity that the project meets the necessary validation standards.

5 Results

At the end of the validation in the XYZ company, the indicators thrown in the second quarter of 2020 after the audit were analyzed. The reports were compared obtaining the following results (Table 1).

Table 1. Indicators

Indicators	Most probable indicator April 2020	Most probable indicator June 2020	Most probable scenario variation
5S Assessment	33%	76%	43%
Waste percentage	12%	5%	7%
Production indicator	83%	94%	11%
NPV			S/. 40,575.59
IRR			47%

Regarding the predisposed indicator analysis, these are validations corresponding to the proposed model development as the validations are governed by susceptible scenarios that may arise within the project implementation with the validation analysis of 10,000 risk scenarios according to the Risk Simulator platform.

As can be seen, there has been a considerable 43% increase in compliance with the development of the 5S methodology. Likewise, this percentage is related to the decrease in the waste percentage, this being 5% achieving a 7% reduction compared to the previous quarter. Finally, we can see that the production indicator increased by 11% more than the previous figure.

6 Conclusions

This improvement proposal applied lean manufacturing tools under the design thinking approach, seeking to convert a differentiating product into a product able to attack a competitive market without partially affecting its growth as demands are more abundant every day, warranting an 11% increase in productivity.

The implementation model proposed and validated by @Risk Simulator reveals that the most probable scenario complies with 10,000 simulations for the accepted standardizations of the range of scenarios, with a NPV of S/40,575.59 and an Internal Rate of Return of 46.85%, which represent a favorable and optimal result for increasing company profitability aligned with production, as per the objectives from the improvement proposal.

The development implications of lean manufacturing under the design thinking approach meet expectations in terms of production indicators and will have to be practical for future research, giving way to an approach directed to the end user.

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Production Management Method Based on Agile Approach and Lean Manufacturing Tools to Increase Production Levels in Peruvian Metalworking MSMEs

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Abstract. In Perú, 90% of companies that employ 50 workers or less have an average life span of only 10 months in the market. This statistic is closely linked to informality and low productivity issues in such companies. Moreover, in March 2020, manufacturing production plummeted to 32.2% owing to low productivity levels exhibited by some companies. Therefore, to improve this situation, a production management method is required to enhance production management at metalworking MSMEs. This research work is based on the design and application of a production method based on lean manufacturing tools and agile methodologies to improve production process performance and meet market demands. Results revealed that manufacturing times reduced to 14.5 min, productivity increased by 30%, and the level of unfulfilled orders reduced by 30%.

Keywords: Agile methodologies · Lean manufacturing · Lean production · Productivity · SMEs

1 Introduction

Currently, the informality and poor management skills of microbusiness owners have led to a significant decrease in the sales of MSMEs, which potentially decreases their productivity levels. According to the Development Bank of Latin America—CAF, regional production growth has been extremely low in Latin America for the last 60 years. In fact, the productivity of Latin American countries accounts for only 27% of that reported by the United States [1]. The manufacturing sector has also been impacted at a global scale owing to the slow growth, sustaining 3.6% of the manufacturing-added value in 2018 relative to 3.8% achieved in 2017. Alternatively, in North America, manufacturing production has experienced considerable growth. Manufacturing production has grown

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 667–675, 2022.
https://doi.org/10.1007/978-3-030-85540-6_84

in the United States from 1.8% in 2017 to 3.1% in 2018. However, in Europe, the growth rate of the manufacturing sector has decreased from 3.5% to 2.6%. Moreover, in East Asia, manufacturing growth decreased from 3.1% to 1.9% [2]. In March 2020, manufacturing production decreased to 32.2% in Perú owing to the low production rates caused by lockdown [3].

Within the metalworking industry, companies must operate at large capacities; otherwise, they will not be able to satisfy the market demand if they lack good production control and management. Because of such a situation, these companies generate less revenue, eventually fading into the market. This occurrence is largely attributed to poor business management practices at MSME levels coupled with little market acumen, inadequate internal organization, and a lack of production planning [4]. A study conducted by the Peruvian Ministry of Economy and Finance identified the factors causing low productivity in Peruvian MSMEs. The main factors include poor employee training, a lack of investment in specialized training, limited access to capital, and little use of modern business practices by micro and small entrepreneurs [5].

2 State of the Art

2.1 Current Production Management in MSMEs

The contributions of MSMEs to the world are clear to everyone because they play an important role in the global economic systems, accounting for 88%–90% in national economies, indicating a significant impact on the national GDP [6, 7]. Current business management models focus on production development, which mainly assesses production activities. However, this approach fails to address production processes that are limited by poor management and resource availability, thus inducing economic losses and permanent closures of economic activities. In this context, research results have revealed that small- and medium-sized companies can become operationally solvent if they adopt management methods and tools supporting productivity and agility [7, 8].

2.2 Lean Manufacturing for the Production Management of MSMEs

Some researchers agree that the lean approach offers high operational potential. Moreover, its methods and tools can be used to streamline production efficiencies, exerting a significant impact on production volumes and maximizing its profitability. Hence, some studies seek to maximize productivity by 20% and reduce production costs [8, 9]. These data are obtained from a study that realized an average saving of $50,000 using lean manufacturing methodology [9, 10].

2.3 Agile and Lean Methodologies for Production Management in MSMEs

Because there is a considerable disagreement in the literature regarding whether these two strategies are mutually supportive or mutually exclusive, the research initiative is not very well defined. However, research has been conducted to verify the impact of using lean and agile practices to provide evaluation criteria regarding their use in project

work. The process of combining both approaches did not yield the expected results owing to a lack of information on simultaneously implementing both approaches to improve productivity and teamwork. Considering this situation, further research proposals are required to encourage the implementation of both approaches [11, 12].

3 Contribution

3.1 Proposed Model

The design and implementation of a production management model using agile and lean manufacturing approaches are divided into four stages. These stages allow the organization of all production actors to adopt a new pace of work. This approach yields faster and more efficient processes, thereby increasing the production level, reducing operating costs, and meeting market demands.

- Planning Initiatives: In this first stage, it is possible to understand the current situation of the company with respect to its competitive environment. The strategic direction of the organization can also be performed along with the planning of implementing a new model that must be communicated to all personnel involved in the production area.
- Support System Development: In the second stage, collaborators coordinate and are trained on lean manufacturing and agile methodologies. Finally, they begin designing the project under these tools.
- Improvement Execution: In the third stage, the implementation of lean manufacturing tools is performed based on an agile approach such as the scrum by conducting three 4-week sprints and daily 30-min scrum meetings.
- Monitoring and Control: Finally, monitoring and control key indicators facilitate the adoption of good production practices by standardizing processes, all aimed at promoting and building a lean culture in the organization (Fig. 1).

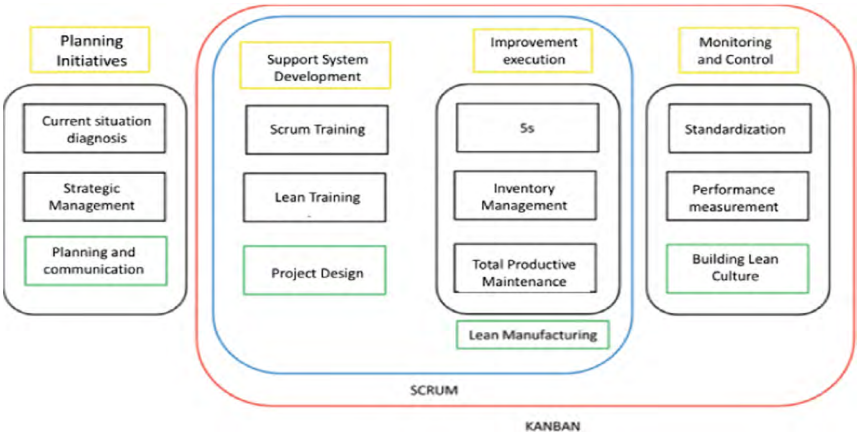


Fig. 1. Production management process

Figure 2 shows the proposed production management model and its stages. This model improves productivity and increases production levels and sales in Peruvian metalworking MSMEs.

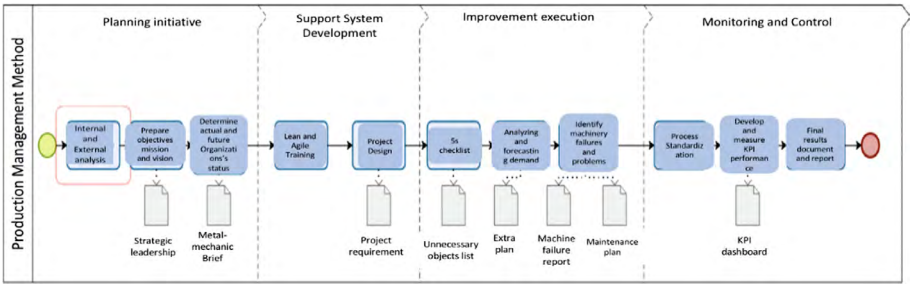


Fig. 2. Production management method

3.2 Process

To appropriately implement the proposed method, an industry assessment must be conducted to better understand its current situation, ways to adopt new tools or technologies available in the market, and determine competing companies. Simultaneously, an internal assessment of the organization must be conducted to verify processes, sales, and personnel. Then, a report is generated based on the current situation of the company.

Thereafter, the description of the objectives and the mission and vision are prepared to engage the strategic leadership of the company and identify the main problem affecting its productivity. Finally, the future state of the company is determined using the metalworking brief.

In the support system development stage, scrum and lean manufacturing training sessions are organized for the production area. In these sessions, a lean manufacturing project will be developed based on an agile approach after identifying the minimum requirements for its development.

In the improvement execution stage, the requirements provided by the metalworking brief and product backlog are developed for each scrum sprint. They are determined for each tool used to improve and standardize all processes that are beneficial for production management. First, a 5S checklist is prepared. Based on this checklist, all unnecessary items and activities are removed. Additionally, this tool is used to standardize activities and discipline operators. In the second sprint, inventory management is established, including analyzing and forecasting the demand to obtain an aggregated plan for the organization. Finally, the total production maintenance tool is used to identify failures and problems in machinery, generating a failure report for each machine. Later, a preventive maintenance plan is prepared.

Finally, in the monitoring and control stage, each tool is assessed based on its respective indicators. If there is an improvement, the obtained results obtained are documented and recorded. If there is no improvement, the project design is re-established.

3.3 Indicators

Production management indicators are used to measure model implementation. These indicators measure and assess the success rate of the production management model implemented in the company.

Damaged Finished Products (5S): This indicator specifies how many products have been damaged within the work area.

$$Total\ Damaged\ Products = \frac{Damaged\ products}{Total\ products} \tag{1}$$

Cycle Time (5S): This indicator is assessed considering process times, and the results are displayed in a traffic light assessment dashboard.

Unfulfilled Orders due to Shortages (Inventory Management): This indicator specifies the number of orders that has been rejected or canceled owing to inventory shortages.

$$Nonfulfillment = \frac{Rejected\ orders}{Total\ orders} \tag{2}$$

Number of Stoppages (TPM): An annual control of stoppages will be conducted for each failure in any production machine.

OEE Machines (TPM): This indicator specifies the efficiency of production machines.

$$OEE = Availability \times Performance \times Quality \tag{3}$$

Productivity: This indicator specifies the number of finished goods in store without any failure or defect.

$$Productivity = \frac{(Amount\ of\ Total\ Orders\ Stored)}{Total\ Production} \tag{4}$$

4 Validation

4.1 Simulation

Scenario. Distribution compiled by Input Analyzer. The information is compiled based on the time spent by each process: arrival, lathe, sanding, riveting, and finishing. The simulation is performed based on the current company production flows, simulating 450 runs in a period of one month of production.

Initial Diagnosis. After validation, initial diagnosis based on previous studies is reported as the basis for subsequent analysis (Tables 1 and 2).

Table 1. Average time

	Traffic Light			Current Situation	5S	Inventories Management	TPM	Proposed Model
Time	>17min	14-17min	<14 min	17.34	14.79	15	16	14.7

Table 2. Noncompliance and productivity percentages

	Traffic Light			Current Situation	5S	Inventories Management	TPM	Proposed Model
Non-compilance%	>12%	5%-12%	<5%	66.68%	19%	16%	22%	12%
Productivity%	<60%	61%-85%	>85%	33.32%	81%	84%	78%	88%

Validation Design. The production process simulation is conducted. Obtained results (Tables 3 and 4):

Table 3. Obtained results: time

	Traffic Light			Current Situation	5S	Inventories Management	TPM	Proposed Model
Time	>17min	14-17min	<14 min	17.34	14.8	16.47	16.53	14.5

Table 4. Obtained results: noncompliance and productivity

	Traffic Light			Current Situation	5S	Inventories Management	TPM	Proposed Model
Non-compilance%	>12%	5%-12%	<5%	66.68%	65.46%	44.27%	63.03%	36.42%
Productivity%	<60%	61%-85%	>85%	33.32%	34.54%	55.73%	36.97%	63.58%

4.2 Three Scenarios

Scenario. The process works based on three possible scenarios: optimistic, neutral, and pessimistic. Results are highlighted based on the outlook and possible probabilities for each scenario evaluated. Templates are used as an assessment method to assess the impact generated using the proposed model.

Initial Diagnosis. The base diagnosis of previous studies is established to perform the assessment after the development of the validation and its results (Table 5).

Table 5. Average result table

		Traffic Light			Optimist	Neutral	Pesimist	Current Situation
5S	Damaged Finished Goods%	>5%	2%-5%	<4%	2%	4%	15%	8.04%
TPM	OEE	<65%	65%-80%	>80%	91%	65%	25%	54.74%
Inventories Management	Stoppage per year	>55	30-55	<30	18	80	140	70
	Shortage due to non-compliance%	>12%	5%-12%	<5%	1%	6%	15%	5%

Validation Design

5S METHODOLOGY. First, we introduce the employed 5S template. Following the established contribution process, this template assesses the results obtained based on its application and correlates them based on the percentage of damaged finished goods (Table 6).

Table 6. Correlation results

Assessment	20–35	36–75	76–100
Damaged finished goods %	>5%	2%–5%	<4%

TPM METHODOLOGY. Once the application process is completed, the efficiency of the equipment is evaluated based on the obtained results using the OEE indicator. Later, machine stoppages are also assessed based on the information provided by the template (Table 7).

Table 7. OEE Evaluation Criteria and Amount of Stoppage: Results

OEE Evaluation Criteria		
<65%	65%–80%	>80%

Amount of Stoppage: Results		
>55	30–55	<30

INVENTORY MANAGEMENT METHODOLOGY. The total projected production of 8,751 pots is considered as a reference. The percentage is obtained by dividing the unfulfilled orders by the total production. Finally, the results are obtained as follows (Table 8):

Table 8. Results obtained

SCENARIO	5S METHODOLOGY	RESULTS	TPM	RESULTS	INVENTORY MANAGEMENT	RESULTS
OPTIMIST	Damaged finished goods %	4%	Macchine Stoppage per Year - OEE	91% 18	Non-compliance due to shortage %	1%
NEUTRAL	Damaged finished goods %	3%	Macchine Stoppage per Year - OEE	66% 90	Non-compliance due to shortage %	5.21%
PESIMISTIC	Damaged finished goods %	11%	Macchine Stoppage per Year - OEE	30% 138	Non-compliance due to shortage %	13.36%
ACTUAL	Damaged finished goods %	8.04%	Macchine Stoppage per Year - OEE	54.74% 70	Non-compliance due to shortage %	5%

5 Conclusions

This research combined both the concepts of agile and lean methodologies with existing production management methods and models to develop a production management method based on an agile approach for MSMEs. Data were collected from a Peruvian metalworking company to simulate the proposed method using the Arena simulator and scenario analysis methodologies, which provided a general overview of the implementation. However, we suggest directly adopting the production management method and implementing it in companies to measure the performance and efficiency levels of their production areas.

According to the results obtained based on the validation of the proposed method, to guarantee a successful implementation in manufacturing companies, we suggest the following:

- The production management method must be used as a basis for organizations because the project design phase largely depends on the results obtained from the current situation assessment of each organization. Therefore, this assessment must be objective and focus on improving their production processes.

- Full commitment from senior management is critical because they lead the production teams in MSMEs. For this reason, they must be engaged from the beginning and convinced that the production management method will have a positive impact on their organizations.
- The optimization of raw material and available operational resources is vital to achieve the ultimate goal of the proposed method: securing high production levels and effectively fulfilling a high percentage of customer orders.

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Education in a Swipe: A User-Experience Framework for Designing Social Network Stories for Engineering Education

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Abstract. Through this study, we present a framework to easily develop Social Media posts to enhance Educational experiences. The framework is validated with a study case including students from different engineering majors, seniorities and courses, who were invited to follow optionally an Instagram account where diverse content related to their specific syllabus was published throughout the sixteen weeks that the courses lasted, and was available only for 24 h. Results were cross-compared with a few Kahoot! quizzes with no negative impact on their grades, in order to validate if the posts designed with the framework helped those students who watched them.

Keywords: Higher education · Educational innovation · Social networks

1 Introduction

According to [1], university students are not able to continuously pay attention during a 50-min lecture in a traditional class environment. This problem intensifies [2] when students are on the other side of a screen, as they can very simply switch navigation tabs to get distracted and there is no in-person contact between educators and students [3]. As students spend a lot of their time in social media [4], the question that arises is: can social networks be used effectively to reinforce topics from the class?

Even before the enforced need to switch from traditional teaching methods to one of remote learning due to the COVID - 19 Pandemic, educators of different levels have been exploring how to improve the learning experience for students in ways different to the traditional master lecture. Storytelling and gamification have thus become trending methodologies among professors willing to present their topics in more original and non-traditional ways, for example, in biology courses [5, 6].

The use of social media for education purposes has also been widely explored since they bloomed. For example, studies have shown that professors that use social media for personal uses, also recognize it as a tool to stay updated in their topics of expertise [7, 8].

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 676–683, 2022.
https://doi.org/10.1007/978-3-030-85540-6_85

However, their study also reveals that most of them agree that they take more time than they are worth. Part of this perception could be related to the fact that many educators are not "digital natives", and thus might find it more difficult to adapt their class to the context of use of social networks. However, according to [9], social networks have a higher capacity to spread information than educational web platforms as they usually allow for more freedom of expression. The problem thus to be resolved is facilitating tools for the professors to optimize their use of social media for education. This paper presents a design framework to construct content for photo-based Social Networks, as it is intended to be more visual. Whilst the concept of sharing temporary images or videos has spread considerably, making it easier for educators to choose from a vast array of tools, some studies have shown Instagram might be amongst the most popular social networks for education [8, 10].

However, it is important to mention that students might also have certain preferences related to the use of social networks. For example, according to [11], designers use Instagram in a great measure to seek creative inspiration. Engineers on the other hand, also use it for that purpose, but in a much lesser frequency. Moreover, Instagram seems to be a more effective tool than Twitter because of its visually dominant platform [12] and Twitter might be perceived as 'a platform for the more knowledgeable, experienced and powerful' [13]. Besides, aspects such as the privacy and the non-uniform use of social media by students could affect the interactions [14].

The purpose of the proposed framework is to provide a strategic approach that can be useful for professors based on the foundations of User-Experience (UX) design in order to better capture the attention of their viewers.

The paper is structured as follows: in the next section, we will present the framework to elaborate Social Media content by applying some of the concepts of User Experience Design. After the framework is presented, a particular case study will be introduced to validate if the overall learning experience for Engineering students was improved by the use of such proposed framework. The results are then presented and discussed.

2 Methodology

To correctly deliver a message in such photo/video-based social networks, the best is to understand what the educator is willing to communicate. Thus, we divided the process into three main steps which will become the framework that the creator (the educators in this scenario) will use to develop their content (see Fig. 1).

It is important to note that the following three steps do not depict three social network stories or posts, but three moments of the content generation, meaning that any of the three stages could contain more than one permanent or temporal post (usually referred to as stories [15]). The three main areas are: The Set Up, Delivery and Closure, each with 3 sub categories or milestones. These steps are given as a guideline to simplify the production of content, but definitely are part of an iterative process that imply acting on the student's feedback.



Fig. 1. Visual representation of the entire 3 step framework for setting up, delivering and closing up digital interactive content via social media apps.

2.1 Setup

On this initial stage we are creating the opening lines, the question or concept to be approached on the following stories or posts. The first and more obvious part is to choose the topics to be approached with the means of social networks. For this, a recommendation is to focus on those topics previously identified as complicated by students or directly by the educator. As mentioned before there can be more than one topic for a week's lecture, so it is important to decide based on experience and knowledge of the entire Career Plan which topics will be used constantly and are of most importance to the alumni during the educational path.

A schedule is of most importance to stay on track with deliverables and content creation, using digital or traditional techniques a Gantt chart or a simple excel file can be used to pin and set dates for when the drafting and content creation should be done by and posted.

Once the topic is selected a process of storyboarding is next in line, storyboarding is essential in content creation since it allows a screenshot of what the content will look like and allows professors to stay in track and not deviate from the subject at hand. Specially to not deviate and end up creating more of a fun meme rather than creating an engaging story telling device.

2.2 Delivery

Once the Setup is established and refined, we can continue to add in the core of the story or post, again by adding reference imagery and easy to translate concepts into visual aids. This is where most of the stories is being generated and where the most engagement is to be obtained in order to successfully deliver memorable content.

Working in tandem with your Social Media of choosing is important, as each platform provides different tools to augment and improve your content: Instagram's UX allows, for instance, to add in interactions to provide a two-way communication channel with students, by adding in open ended or closed questions as well as meter bars or even music to add a bit of fun to the theme itself.

At this point, it is important to consider the final elements of the content of the post or story, reinforcing concepts and statements to emphasize the importance of the reviewed content.

Once all the content has been drafted as a matter of storyboard we start on Graphic Design followed by upload to social media. Whilst keeping back and forth with the Social Media's UX and its plethora of tools to make content more engaging. Some recommendations include the use of the Gestalt Principles, Rule of Threes, Gaze Tracking and Hero's Journey [16].

By using tools such as Adobe Illustrator, Adobe Premiere Pro and Adobe Photoshop (or free tools such as Affinity Designer, Camstasia or iMovie) graphics can be tweaked, cropped, edited and cleaned up to be used on Social Media stories or posts. An important consideration is the posting size (e.g. Instagram has 1080 × 1920 pixel size in portrait view but users can flip their phone sideways to go landscape mode, making it more engaging as more space for imagery and content overall).

2.3 Closure

After the content has been drafted via storyboarding, using graphic design tools to create finalized designs and it has been uploaded to the Social Media, the final step would be to analyzed the data provided by the Social Media itself, whether having access to marketing tools to mine down more in depth data or simply by using the Social Media's own analytics we can get enough information to compare to alumni who did not follow or engage with the content. This will allow adapting the future content to the public and make it more interesting for them.

3 Case of Study

To test and validate the proposal, a study was carried out at *Tecnológico de Monterrey*. This study was carried out throughout two different semesters: February–June 2020 and August–December 2020, hence referred to as S1 and S2 cycles respectively. An Instagram account was created to post different groups of stories related to the classes in which enrolled students would participate. For this study, different groups of stories were created: to explain a topic, to extend its context, to give an example, or to ask the students for interaction to demonstrate they had understood the topic.

These groups of stories were posted according to a schedule that took into consideration the topics of the weekly classes (sometimes topics were presented before the classes, but most of the time just after they were introduced in class). The groups of stories would be available for 24 h each, period after which they would disappear but leaving data of the Instagram accounts who watched them. The groups of stories would have a minimum of 2 stories (usually 2 pictures lasting 15 s each unless the user swiped to the next) and a maximum of 24 (longest ones were edited videos lasting a maximum of 4 min).

To evaluate the impact of the groups of stories in the students, several Kahoot! quizzes were carried out during the semesters. Students were aware that the quizzes would happen but wouldn't know when they would happen. Moreover, these quizzes

were not part of their grade, but some extra points were given to the leaders as an incentive.

To players who answered correctly, Kahoot! assigns points based on speed of answer [17]. This would serve to identify if students watching the stories would earn more points in average than those who did not watch the stories. The participants that agreed to participate in the study can be divided as follows:

During the S1 cycle, a total of 31 senior undergraduate mechatronic students participated. These students were enrolled in either the Mechatronic Design course, Mechatronics Laboratory, or both. Only 25 of them were following the Instagram account created for the sake of the study, but without any guarantee that they would observe the totality of the stories, as no calendar was given to the students. In total, 23 different groups of stories related to Product Design were presented throughout the cycle. Topics included aspects related to prototype design and business considerations as both courses are complementary [18].

During the S2 cycle, viewers from the S1 cycle were eliminated from the list of followers. The posts related to Product Design were posted again following the same posting calendar than on the S1 cycle with 33 senior mechatronic students enrolled in Mechatronic Design and/or Mechatronics Laboratory participating in the study, from which 19 were following the Instagram account. Moreover, the same Instagram account was used during the S2 cycle to post topics from two additional courses:

- Process Automation, with 25 enrolled students willing to participate in the study. These students were senior undergraduate chemical engineers and biotechnology engineers. Only 11 out of the 25 followed the account. For this course, 9 groups of stories were presented during the 16 weeks of the semester.
- Logic Automatism Laboratory, with 7 students willing to participate in the study. They were second-year undergraduate mechatronic students. Only 4 out of the 7 were following the account. For this course, only 5 groups of stories were introduced throughout the semester, as the laboratory covered less topics than a more theoretical course due to its practical nature.

To make it easier for students to focus on the stories that would matter to them, a splash screen would introduce the course for whom it was aimed.

4 Analysis of Results

To reduce bias from the researchers, the results were analyzed until the study had completely ended. Students participating in the test allowed for an association of their Instagram accounts with their student ID number in the quizzes. An important thing to consider is that, to randomize a little bit further, not all groups of stories had a related question in Kahoot!, and not all questions from the quiz had a related group of stories.

Thus, a match between the points awarded by Kahoot! and the story views would be made to average the number of points between those who watched the related stories and those who didn't see them, in case such a match existed. This would allow us to get a value that wouldn't be affected if there were more or less students watching the group of stories.

The points would then be added together for a macro analysis. Since more complicated questions would stay longer on screen than simple ones, a decision was made to normalize the points with respect to the highest number of points awarded at each question and to disregard questions in which no single student had seen the associated stories. Moreover, whenever several questions of the same topic would appear in the Kahoot! quiz, they would be averaged together regardless of the difficulty level.

Figure 2 presents some of the results, separated by course and ordered chronologically. We can appreciate that for each course results are very distinct: In Process Automation, most of the students that have watched the stories got worse results (a deeper analysis shows that most of the students who started watching the story but dropped it before the end got wrong answers) in relation to those who didn't watch the stories at all. In the Logic Automatism Laboratory however, the students watching the stories had a higher success rate than those who did not. Finally, for Mechatronic Design and Mechatronics Laboratory students, viewing stories seemed to have a better impact overall, even if it didn't work out for all the groups of stories. The addition of points in all courses show that the average score of students in the three courses was higher approximately 8.45% in those who watched the stories in contrast to those who did not.

Further analysis was done in relation to the difficulty of the question. They were separated in 3 main groups: hard questions (whenever less than 35% of the students taking the quiz got the right answer), medium questions (having between 35% and 70% of students answered correctly) and easy questions (over 70% of students got the answer right), obtaining 11 hard questions, 15 medium, and 11 easy. By looking at the rate of success (defined as the number of questions in which students looking at the group of stories got a better average than those who did not), it was observed that the impact was much more pronounced whenever questions were simpler (see Fig. 3). Figure 3 also shows the level of engagement according to the number of stories in the group. It can be perceived that having groups of stories of less than 10 parts provides a higher rate of engagement among students.



Fig. 2. Performance of students in Kahoot! Quizzes with relation to the questions akin to a set of stories for Process Automation (left), Logic Automatism Laboratory (center) and Mechatronic Design and Laboratory (right). Dashed blue lines indicate the normalized average of students that watched the stories and regular red lines indicate the normalized average of those who did not watch them.

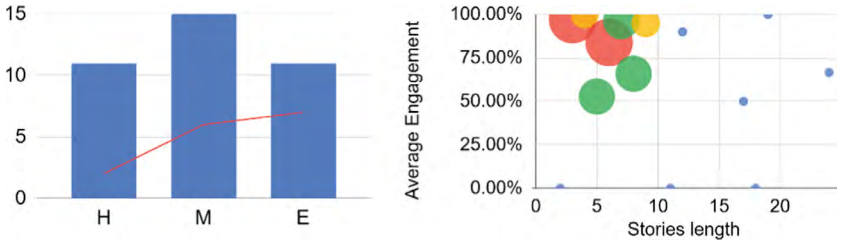


Fig. 3. Left) Bar charts indicate the number of stories categorized as hard (H), medium (M) or easy (E). In front of it, the number of questions in which a performance improvement was found when students watched the stories Right) Engagement rate (y-axis) in relation to length of stories (x-axis). Size of the circle indicates frequency.

5 Conclusions and Discussion

Through this paper we present a methodology to simplify the generation of Social Media posts for education. By applying this methodology, we validated that the content generated with this framework had a certain impact on the students, even if it was not enormous. However, it is important to understand that some variables were outside of the researchers' control, such as the Internet speed connection of the students.

To support the quantitative results, an exit survey was conducted just for the Instagram followers. Most of the people voting through the application indicated that the stories were useful to reinforce the overall learning, to understand better certain topics, and that they would like this initiative extended to other Engineering courses. Moreover, certain students even used the social media platform to ask further questions and interact with the stories generated.

An interesting phenomenon was that these interactions were more frequent during S1 than during S2, perhaps because in the second case students were less enthusiastic about screen time as classes were completely online. Related to the exit survey, they also indicated a preference for practical activities, and the use of pop-culture characters.

Some future work can include a deeper analysis in the understanding of engagement due to diverse factors (such as the ones presented in [19, 20]).

Acknowledgments. The authors would like to acknowledge the financial support of Writing Lab, Institute for the Future of Education, Tecnólogico de Monterrey, México, in the production of this work. We would also like to thank the students who willingly participated in this study.

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Lean Green Production Management Model Under a Circular Economy Approach for Reducing Variable Costs at a Small Plastics Business

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Abstract. This paper proposes a Lean Green model for increasing profitability in small and medium-sized businesses operating within the plastics sector. This model will use the 5S methodology, KanBan for inventory control and TPM to standardize new corrective and preventive maintenance processes. As an added contribution, a Circular Economy process will be included to reuse products, thus reducing consumption and generating less solid waste. In this way, companies will not only prevent damaging the environment but will also guarantee their compliance with regulatory standards. As a result, an 11% reduction was observed in the acquisition of supplies and spare parts for machine maintenance along with a 4% reduction in the number of machine breakdowns.

Keywords: Circular economy · Kanban · Lean Green · Variable costs · 5'S

1 Introduction

On a worldwide scale, the plastics industry plays an important role. Currently, Asia accounts for approximately 50% of the plastics production around the world, followed by Europe at 19% (mainly focusing on production of raw materials and general plastic products). In Peru, this industry represents 4% of the country's industrial GDP and generates around 52,000 direct jobs in both the plastics production and import segments. Most of the companies operating in this sector are small and medium-sized manufacturers of plastic products for the mining and construction sectors, which means that their growth is proportional to the growth reported for these industries.

According to our study, the main challenges faced by small and medium-sized businesses operating within the plastics sector are related to rising raw material costs, inadequate labor allocation, and specially, maintenance costs. These issues are deemed relevant because the plastics sector contributes to the Peruvian economy both directly and through other activities. Likewise, if this sector complies with all the standards and starts operating from a different perspective, it will have positive impacts on society.

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 684–689, 2022.
https://doi.org/10.1007/978-3-030-85540-6_86

2 State of the Art

2.1 Production Management Model for Small and Medium Plastic Businesses

This section reviews academic papers clearly focusing on Production Management applied to the small and medium-sized businesses operating within the plastics industry. First, most authors propose eco-friendly models developed through quantitative methods applied in agricultural industries. Their success is measured using the regression calculation, through which they obtain lesser values than the original estimates, thus generating sustainable results [1, 2]. Likewise, other authors implemented production models aiming to decrease reprocessing rate, increase delivery deadline compliance, and reduce defective products, thus generating significant savings for the company. For example, a plastic company managed to reduce its delivery time from 30 min to just 5 min, evidencing a positive impact on process times [3, 4]. In addition, these papers also reveal that production costs are often associated with final deliveries to the customer. In this sense, the models proposed by different authors agree that this may be addressed by managing quality costs, such as reprocesses, delivery, waste, defective products, and even return costs. However, as the production improvements were implemented, these indicators decreased [4, 5].

On the other hand, the conclusions reported by these authors at the end of their papers should be reviewed. As they claim, environmental impact will sooner or later become a key factor for business development and will generate competitive value for customers. Hence, the methods implemented must be quantitatively supported so that the companies may exactly know their environmental footprint and take appropriate actions accordingly. At this point, most authors also agree in discussing and addressing production waste [1, 3]. This is a critical issue because adequate waste management may be able to generate additional revenue for the company as its capabilities are fully leveraged. As it may be observed, Production Management models are quite diverse, and none is better than the rest. Some models are simply better suited for a given company based on its existing conditions (we only assessed small and medium-sized businesses operating within the plastics industry) [3, 4].

2.2 Lean Green, Circular Economy, Production Management Model for Small and Medium-Sized Businesses

Finally, this section cites conclusions and results obtained by authors who implemented a Production Management model using the Lean Green methodology and a Circular Economy. In the literature reviewed, at least two authors demonstrated a positive correlation between the Lean and Green methodologies, obtaining positive performance indicators and in one particular study, achieving a reduction in automobile water consumption [6, 8]. In addition, a couple of authors agree that the good Lean Green practices implemented at a manufacturing company by eliminating or reducing the seven wastes had a direct positive impact on their environmental and operational performance. Furthermore, these improvements also exerted a positive effect on green supply chain practices, concluding that these three steps complement each other and align well with corporate goals [6, 8]. On the other hand, these authors warn us that implementing agile methodologies in a

company is already complicated, and that if we were to add to an environmental sustainability vision and perspective, their implementation would be ever harder. Consequently, if these two tools were implemented at a manufacturing company, the authors focus on measuring their success expectations in environmental and operational terms [6, 7].

Finally, Zhu addresses the proper implementation of Lean Green and Circular Economy using coal production measurement methods and optimizing processes, as this can help the company identify waste management improvement opportunities based on variables such as time, energy, materials, and coal transportation [9].

3 Contribution

3.1 Rationale

For the development of the proposed model, the reviewed literature was used as a referential foundation, because some of the reviewed papers agreed in some respects. In addition, these papers also evidenced that most of the small and medium-sized businesses operating within the plastics sector, at a worldwide scale, are still manufacturing companies. Within this context, the proposed model focuses on improving production processes and encouraging good supply practices. Another important model cornerstone comes from Lean Green: engaging company employees in implementing comprehensive improvements. On the other hand, as it has become popular in recent years due to new environmental laws and has not been well researched yet in the literature, we decided to supplement our Lean Green model with Circular Economy and its three phases: production, consumption, and recycling. In this way, we would be able to introduce environmental sustainability in the company. Finally, the outputs generated from this production model are a reduction in material costs (variable costs), an improvement in customer relations and the creation of new environmental policies, thus making the plastics industry eco-friendlier.

3.2 Proposed Model

Variable Cost Reduction model proposal using Lean Green and Circular Economy tools (Fig. 1).

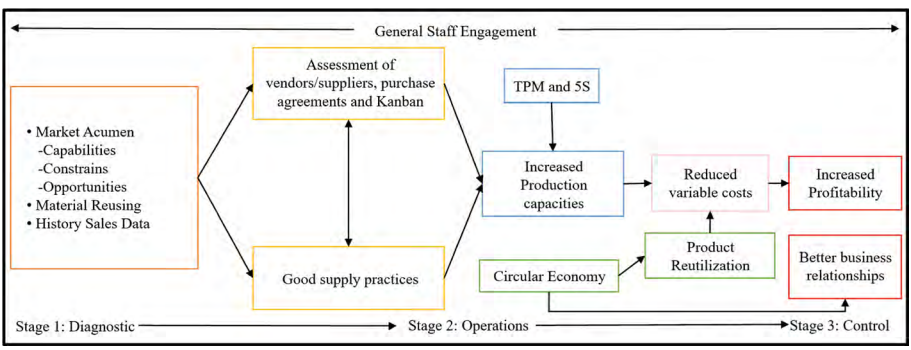


Fig. 1. Proposed model

3.3 Proposed Method

Figure 2 shows a flowchart that denotes the new purchasing process for both raw materials and spare parts, considering the KanBan methodology already implemented.

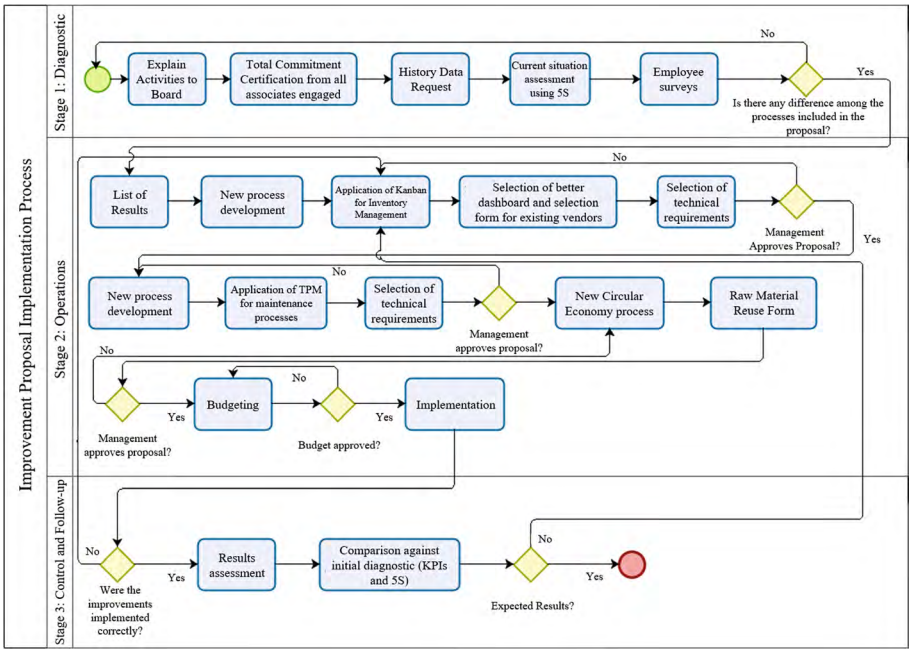


Fig. 2. Model implementation flowchart

3.4 Indicators

- Percentage of raw materials purchased against total sales.
- Average downtimes (machine breakdowns) between scheduled outages.
- Percentage of machine repair costs against total sales.
- Current percentage of 5S compliance.
- Percentage of raw materials reused against total raw material used.

4 Validation

4.1 Description of Case Study

The proposed model was validated at the Polisa SRL company in the city of Chiclayo, because of the great potential for improvement it exhibits and the amount of history data provided for this research study.

4.2 Initial Discussion

Three different scenarios will be assessed to determine possible results in three different simulated contexts:

- First Scenario: Pessimistic.
- Second Scenario: Expected.
- Third Scenario: Optimistic.

4.3 Results Analysis

See Table 1

Table 1. Results analysis

Results analysis					
Scenarios	Indicators				
	I 1	I 2	I 3	I 4	I 5
Initial Scenario: Diagnostic	56.0%	2.50	7.0%	37.5%	0.0%
Scenario 1: Pessimistic	49.0%	2.18	5.0%	60.0%	5.0%
Scenario 2: Expected	45.0%	1.93	3.0%	80.0%	10.0%
Scenario 3: Optimistic	38.0%	1.83	2.5%	100.0%	13.0%
Statistical Analysis					
Mean	44.0%	1.98	3.5%	80.0%	9.3%
Median	45.0%	1.93	3.0%	80.0%	10.0%
Std. Dev.	5.6%	0.18	1.3%	20.0%	4.0%
Variance	0.21%	0.02	0.01%	2.67%	0.11%
Max	49.0%	2.18	5.0%	100.0%	13.0%
Min	38.0%	1.83	2.5%	60.0%	5.0%
N	5	5	5	5	5

5 Conclusions

Regarding the initial diagnostic phase, the 5S audit tool was used to find out the point of departure for the study; the result was 37.5%. After implementing the proposed improvements, a second audit revealed that we had reached 80%, which is a considerable improvement.

To solve the raw material issue, a new procurement process was established, including inventory review, vendor background checking, and Kanban support.

For maintenance, we implemented the TPM tool, decreasing maintenance costs, and increasing machine efficiency, as validated through the Arena simulator.

An additional process was proposed for reusing raw materials through Circular Economy, which evidenced that the implementation of the Lean Green model will not be successful without active engagement from all the stakeholders, including customers and vendors.

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Compressive Stress Analysis in an Underground Mining Geomechanical Model with Long Holes for Stability in Advance Work through Uniaxial Compression Tests

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Abstract. Currently, the way of working was affected by the pandemic we are experiencing and mining is not exempt from this. For this reason, preventive action plans had to be implemented to restart operations in all areas involved in the mining sector. In the execution of these operations it is necessary to review the operating protocols and see if they are effective for the continuity of the mine as well as the stability at the time of exploitation. Mining is carried out under different methods depending on various geomechanical, geotechnical and design factors, where balance is sought. The different mining methods include cutting and descending fill with long underground drills. For this reason, the current geomechanical design should be reviewed in order to identify the stress values that indicate better stability and that have as a consequence the reduction of events caused by rock fall.

Keywords: Accidents · Rock fall · Down-fill cut and fil · Underground mining · Long holes · Stress deviation

1 Introduction

Mining has been essential for the development of communities and societies in general, since the time of the Inca empire, where metals were extracted that to date represented a significant or representative value greater than in our days; For them, metals such as gold or silver were highly appreciated by high society, where not only was the extraction of metals carried out, but they were skilled in metallurgy, since they gave shapes to the metals to adapt them to their body, as well as their mixture. Later at the time of the conquest where foreigners came in search of great treasures based on myths and legends.

Like other important sectors in industry, this industrial activity has a hazard rate that, unlike other areas, tends to be higher than average. This can have multiple factors, as it

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 690–697, 2022.
https://doi.org/10.1007/978-3-030-85540-6_87

mostly depends on the regulations and the safety culture that exists at the national and sectoral level of the country. The risks that can be found can be due to causes external or internal to the worker. Despite the regulatory changes at the national level to improve the safety culture and depending on the type of specialized work that can be carried out at the level of mining companies or contractors, the rate of severity, accident rate or frequency of accidents is usually high in these cases. It is therefore necessary to guarantee for each means, zero accidents in this sector, since it implies an expense for both parties, the contractor company and the owner company.

Finally, the objective of this research lies in the contribution of the know-how to address the problem of rock fall due to poor mining design in advances that exceed 25 m in height, leaving a review and revision for the future. Improvement in its design with methods used in similar projects, where the same exploitation methods are used under different variables. The stability of the rock in a mine is a valuable and essential objective that can improve the advance per day, reduce the dilution of the mineral, improve the safety of the workers and equipment. All these benefits that can be achieved by solving this problem are summary in obtaining better benefits and reduction of project operating costs, thereby increasing profitability in the company.

2 State of the Art

2.1 Geomechanical Factors Identification Model in Mining Operations

The extraction in the mining industry is based on different mining methods, within these the method of cutting and descending fill or Under Cut and Fill (UCF), for its acronym in English, in combination with the use of long holes to increased production, reducing mining costs. The type of support or support used for this design was grouted cement for filling the voids generated was Minova Tekseal. The material was non-toxic, which allowed the correct and efficient handling by the workers. It was filled with 48 bags containing 45 kg of Tekseal, which was used for the cement mix. Once the mixture was made, PVC pipes were used, along the wall to the surface, where said cement would be pumped, where the main contribution was the rapid formation which set in 5 min, reaching its maximum resistance to the compression in just 10 days. After that, no deformation or loss of its integrity was found in the compound, when the walls that served as support in the mineral recovery were removed. While some authors indicate that finding voids caused by long holes during extraction hinders productivity and affects the safety of workers and equipment, others indicate that despite the existing voids, greater optimization is achieved at an economic and geological level [1–4].

2.2 Compression Tests in the Study of Geomechanical Factors

While the occurrences that appeared in the stresses within the holes were being recorded, the potential influence on stability was determined, where the rock mass was the most affected at the time of drilling and blasting. Other studies showed a different mining technique, where there are no pillars during extraction through long holes in coal mines [2, 3]. Other authors aimed to reduce the bypass ratio in safety and production costs,

increasing the recovery of resources, using a mining technique without support pillars with retention at the side entrance, obtained through long holes, relieving pressure. Through the directional cuts of the roof box and the formations obtained by the pressure of the ground and the expansion of rupture of the rocks. The increase in the resource recovery rate of a mine without pillars as support is only applicable in horizontal and thin veins, where pressures are low and the stabilities of the underlying strata are controlled [2, 3].

2.3 Direct Traction Tests Applied to the Investigation of Geomechanical Factors

Each of the indicators were selected and measured in order to make a description of them. Samples were taken with the SIMB 21 (ATLAS COPCO TODAY EPIROC) Model H1254 equipment, dependent and independent variables were defined, previously collected data were processed, where the criteria were standardized and infiltrated, atypical or unreal data were discarded. Their results were conclusive, depending on the type of area to be mined, a diameter of 89 mm was appropriate over that of 64 mm, because it covered more rock volume. Finally, these analyzes could not be completely conclusive without a numerical analysis of the entire mining cycle in the long hole method. That is why in one of the articles, it is discussed that with an index of compound long holes in 2016, a numerical study was prepared for the stability of the rock mass that allows to continue using the long hole method at greater depths, without cease to be economically viable or cause harm to personnel or equipment. Within the contribution of these authors is the distribution of loads in the joint pavilions to the mining cycles; the total forces and axial forces developed along the Tajeos will indicate how the rock has to be drilled and how much power to use [5–7].

3 Input

3.1 Proposed Model

The realization of samples of the geomechanical design present in the studied vein will influence the generation of rock fall. The current geomechanical design of the company is determined with a high percentage of stability, but not enough so that there are no accidents or dangerous incidents. It should be considered that if a change were made in this design, the application cost would be relatively high, which is a limitation.

By comparing the geomechanical factors identified in the design, the stresses obtained in the cores when used in the geomechanical design will be indicated. In this way, we want to achieve a more stable design, since it is an influential expense and which must allow a deviation of uniform efforts that allows the stability of the structure of the rocky massif. This system can be performed by testing samples that indicate common lithological characteristics, with which the in-situ values are tested under standardized conditions to demonstrate the type of support and manage a safety factor with limitations depending on the deposit.

3.2 Model Components

For the collection, tabulation, analysis of data and execution in accordance with the indicators, the necessary tools and relevant documentation must be had within a mining plan in which it can be contrasted with the accident investigation and everything that allows the identification of the factors that originate the incidence of rock fall, so that an analysis for its prevention and/or mitigation can be elaborated.

With the use of the software for the elaboration of the mining plans (Datamine UG with the MSO tool) it is possible to slow down the useful life of the mining. Datamine UG makes it possible to discover correlations in the middle of the database, which are of extensive dimensions so that insight is obtained with new potentials for economic coverage. The reduction in costs produces a focus of effort and investments for the public that is more prone to convert, a potential conversion rate is achieved due to the assertiveness and personalization of the offers, consequently the patterns that lead companies to create solutions are identified. More elaborate and finally, the elaboration of statistical models for the realization of assertive predictions.

The RockScience program is also introduced, which allows the determination of geotechnical parameters of rocky masses under different stresses. It is essential in the study of tunnels or underground cavities, mining, large earthworks or foundations with large loads supported on rock. RockScience is a program with an intuitive interface that allows determining a large number of geotechnical parameters according to various models such as Mohr-Coulomb, generalized Hoek-Brown, Barton-Bandis or Power Curve. Likewise, it allows the analysis of the main stresses and the use of numerous laboratory tests (uniaxial, triaxial compressive strengths, direct cuts or tensile tests) or simply by introducing some basic parameters obtained from stations or geomechanical surveys (GSI).

Finally, the Excel extension called @Risk, so that risk analysis is performed using simulation to show multiple possible results in a spreadsheet model, and tells you how likely they are to occur. Computes and controls mathematically and objectively a large number of possible future scenarios and then indicates the probabilities and risks associated with each. This means that you can decide which risks you want to take and which ones to avoid, making the best decision in situations of uncertainty.

3.3 Proposed Method

Geological comparisons will be carried out through laboratory tests on the samples that have been collected in field, so that the base properties of the rock massif and geological record are convincing to the passive support that may exist in the study area. These tests will be of two types (compression and tensile tests), so that the indicators remain stable. For this, the correlation of Bieniawski and Barton's Q is essential so that the geomechanical characteristics of the massif and the geometry of the deposit are similar both those indicated by the mine itself and those obtained in laboratory tests. In this way, the types of support that are equivalent to the type of geology and the changes that can occur for an economic improvement and passive or active instruments of support to achieve a suitable safety factor are demonstrated.

3.4 Indicators

The database will conform to the one provided by the company as well as the results of its compression and traction tests, which will be contrasted with laboratory tests to determine if there is similarity. Before starting the investigation, you must have the permission of the company to be able to use three samples from a work zone. If the proposal is accepted, the necessary resources begin to be approved through the various areas of the company, such as logistics where all the necessary inputs and data will be provided for the project to be feasible and measurable.

4 Validation

As a first result, the characteristics of geology primers and the results of the compressive and tensile force tests provided by the company and its trusted laboratory reflected in the RMR and Barton Q are indicated.

In the second instance, the factors identified by the company are identified (Table 1).

Rock type: Silisified phyllite: Rocky massif
Pe = Specific gravity
Pe = D (g) = 2.45 (9.8 m / s2) = 24.01 KN/m3
$\sigma c = 10\ (0.00088)\ (Pe)\ (Ir) + 1.01$
Where:

σc = Uniaxial compressive strength (RCU)
Ir (horizontal average hammer rebound index) = 40.125
Pe (specific weight) = 24.01 KN/m3
σc = 10 (0.00088) (24.01) (40.125) + 1.01 σc = 100.8477431 + 1.01
σc = 101.8577 σc = 72.06 MPa

Rock type = Virginia Vein (mineral) D = Density.
Pe = Specific weight.
Pe = D (g) = 3.02 (9.8 m/s2) = 29.596 KN/m3.
$\sigma c = 10\ (0.00088)\ (Pe)\ (Ir) + 1.01$.
Where:

σc = Uniaxial compressive strength (RCU).
Ir (horizontal average hammer rebound index) = 37
Pe (specific weight) = 29.596 KN/m3
σc = 10 (0.00088) (29.596) (37) +1.01 σc = 100.964 + 1.01
σc = 101.974 σc = 94.19 MPa

As a third result, it is indicated that the results of the geotechnical map indicate the presence of volcanic rock made up of porphyritic lavas of andesitic composition, with intense fracturing, with the presence of euhedral phenocrysts, moderate to weak fracturing. In the DLEP-A07 hole, from which the tests with which data are to be compared

Table 1. Rock classification table by Bieniawski classification RMR control.

Basic RMR and corrected RMR – level 920 – 1020, sublevel 308 – 2 progressive 00.00 – 26.00		
Parameter	Quantitative results	Assessment
Uniaxial compressive strength (Mpa)	62,15 Mpa	7
RQD	68,80%	13
Spacing	200–600 mm	10
Persistence	10–20 m	1
Opening	Ang. 0,1–1,0 mm	3
Rugosity	Slightly rough	3
Stuffed	soft < 5 mm	2
Weathering	Slightly rough	5
Underground water	Dry	15
Basic RMR		59
Adjustment by orientation of discontinuities		−5
Corrected RMR		54

were obtained, volcanic rock can be found, made up of porphyritic lava of andesitic composition, greenish gray, with sporadic sections of sub-rounded self-overhangs and light reddish tones, an agglomerate of andesitic composition, reddish gray, with polymictic sub-rounded lithics between levels 6.6 and 222.4. While at lower levels are found lithic ba lapilli of andesitic composition of a greenish-gray color, with content of polymictic lithics and a volcanic agglomerate of a greenish-gray andesitic composition, subangular to sub-rounded polymictic fragments. As additional data, there is a subvolcanic with a fluid, porphyritic texture, with the presence of subangular box rock lithics.

Knowing so far the characteristics of the geological and geotechnical zone, it is indicated that there is a variation in the values of the F.S. for different types of bolts. This reveals that the type of bolt used directly affects the stability of the massif, an aspect that is not included in the support design method; this differentiation between elements allows to give versatility to the design and to better apply the stability requirements with the characteristics offered by the market for the use of bolts.

5 Results

The results of the geomechanical analyzes obtained in the laboratory of the three diamond drillings carried out that were collected and that have served to be able to interpret the geological behavior as a whole in depth were integrated, reaching the definition of the metallic content values as referential for the following works to be carried out in this vein system. The mineralization at depth is not fully recognized as the mineralization shown is considerably crack-fill. It can be deduced that the mineralization has produced a strong alteration of the volcanic rocks located in the zone causing the moderate to weak

argillic alteration with the presence of smectite product of the alteration of plagioclase, and a propilitization in the lapilli tuffs forming chlorite, a late event has allowed the location of low content of primary sulfides of proustite and essentially pyrargyrite at temperatures below 250 °C, the presence of self-overruns is not relevant.

With the cut and fill method, a safe, productive, low-cost and profitable mining is obtained, by 2020, currently at the Pallancata mine 70% of the production comes from long holes and descending cutting and filling. Currently, the company's objectives are basically aimed at reducing rockfall accident rates and improving productivity rates, which are directed at the importance of preparing new designed pits, according to the future infrastructure required by the method. of Long Drills (UCF), with objectives of higher productivity, less exposure of personnel (remote control equipment) and lower operating cost, due to the characteristics of the rocky massif of the mining area in the lower zone where the quality of regulating or average with an RMR ranging from 40 to 45; determining a basic RMR of 59 and a corrected RMR of 54, at level 920–1020, sublevel 308 – 2, progressive 00.00–26.00 m, it is a medium or regular rock at an RMR of 40 to 60, so succinctly, a RMR of 47 for roof box and an RMR of 47 for floor box has been determined in sublevel 308 – 2 in adjacent progressives, which was not mentioned in the study under discussion, regarding the geometry of the mineral deposit has been evaluated in several stations achieving a minimum dip of 59° NE and a maximum dip of 75° NE respectively, the vein width is 3.07 m and the mining width is approximately 4.00 m, considering that they have been carried out in lithological places and structures different. The fundamental parameters for the application of the datamine UG software have been duly evaluated, the results of which suggest the method of exploitation of long holes with very good economic benefits for Cia. Minera Hochschild.

6 Conclusions

The diamond drilling concluded a good sampling; The length of the samples of interest was measured by making the cut considered representative, the samples were separated into twin samples, fine whites, thick whites, thick duplicates, fine duplicates or internal duplicates, standards, and external duplicates, in order to obtain the geochemical results in the laboratory.

The diamond drilling concluded a good sampling; The length of the samples of interest was measured by making the cut considered representative, the samples were separated into twin samples, fine whites, thick whites, thick duplicates, fine duplicates or internal duplicates, standards, and external duplicates, in order to obtain the geochemical results in the laboratory. According to the drilling log, in a simplified way, the lithological characteristics associated with the mineralized structures under evaluation are: the Pallancata Vein, which is located entirely in volcanic rock with a dacite to andesite composition, and the EP Vein is located in volcanic rock towards the extreme west and in phyllites to the east in shorter length.

The diamond drillings that cut the Pallancata and EP vein system were carried out, as well as the respective geological logging was carried out to determine new mineralization zones, or the continuity of veins that make up this system that allows to define in depth the geological and mineralogical behavior and structural of the vein system.

The geomechanical characteristics obtained by the laboratory tests determined that both the RMR, RQD and the resistance to compression and simple traction determined that the long-hole method used in the Pallancata mine is feasible due to the type of rock. According to the adopted geomechanical classification criterion (Bieniawski, 1989), the rock mass associated with the mineralized structures under evaluation has characteristics of variable quality.

For the Pallancata and EP veins, the quality of the ore and rocks in the boxes generally ranges from fair (RMR 41–50) to good B (RMR 61–70). The remote boxes are of better quality (Regular A) and are more homogeneous. In the case of the Suyamarca Body, the rock mass of both the mineral and the boxes is of regular quality (RMR 51–60). The rocks associated with the Pallancata Mine they generally have uniaxial compressive strength between (45–70 MPa and 70–100 MPa): moderate to high resistance. It has been estimated that the vertical in-situ stresses would be in the order of 45.25 MPa, corresponding to a lithostatic load of 1200 m (Pallancata) and 900 m (ML) in height, and the horizontal NS and EW in-situ stresses they would be 45.92 and 42.68 respectively.

The compression stresses before the sample fails are: Company = 76.06 MPa vs 25.90 MPa from the UPC laboratory. The corrected RMR and RQD are: 54 and 68.80% respectively, thus indicating a fair to good grading rock. Therefore the type of mining method is consistent and the support based on Barton's RMR and Q is also consistent. (Normal 41–60. Bolts - Thickness 1.5, $L = 1.8 + (0.18 \times W)$, Shotcrete 50 mm and zone c, systematic bolts from 1 to 1.5 m respectively).

The use of the U.C.F. with long holes reduced the I.F. of 3.5 to 2.4, so it is correct to say that the use of geomechanical factors will reduce rock fall accidents.

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Comparison of Auto-Encoder Training Algorithms

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Abstract. Training of deep neural networks is difficult due to vanishing gradients. Therefore, a pre-training procedure based on restricted Boltzmann machines is suggested to resolve this problem. However, new developments in deep learning aim to resolve the problem with vanishing gradients by using rectifier linear units (ReLU). This study compares the performance of a RBM pre-trained auto-encoder with sigmoid activations to the performance of auto-encoder with ReLU activation. The results showed that the ReLU auto-encoder achieved better reconstruction and saved training time, since it doesn't require pre-training .

Keywords: Deep learning · Restricted boltzmann machine · ReLU · Auto-encoder

1 Introduction

Auto-Encoders are deep feed forward neural networks used for dimensionality reduction [1]. The advantage of the auto-encoder over methods such as Principal Component Analysis (PCA) is that they can capture non-linear dependencies.

Since the auto-encoders have many hidden layers, it is hard to train using error back-propagation [2, 3]. The reason for such difficulties is that the gradients are vanishing. Therefore, unsupervised pre-training procedure based on restricted Boltzmann machines (RBM) is used [3, 4]. The RBMs are stochastic neural networks which can learn the probability distribution of input data [5, 6]. RBMs are used for feature extraction [7–10], and anomaly detection [11].

A study by Tan et al. [12] compared a stacked auto-encoder, a stacked auto-encoder with RBM pre-training, and an auto-encoder with RBM pre-training. The results showed that the best performance was achieved by the stacked RBM pre-trained auto-encoder. Nuha et al. [13] showed pre-training with RBM increases the training time even for auto-encoder with just one hidden layer.

This RBM pre-training technique is used in different applications [14–19]. Also, RBMs are used as part of the error back-propagation training at each iteration [20].

Recent developments in deep learning, however, have resolved the problem with vanishing gradients by using rectifier linear unit (ReLU) [21] and weight initialization techniques such as Xavier [22]. This allowed for very deep networks to be trained such as MobileNetV2 [23], Xception [24], UNet [25], SegNet [26]. A study by Zhou et al. [27] in

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 698–704, 2022.
https://doi.org/10.1007/978-3-030-85540-6_88

which stacked auto-encoders are compared with auto-encoders trained with only back-propagation also shows that the back-propagation algorithm results in better models than the greedy layer-wise training without fine-tuning.

The previous studies by Hinton [3], Tan [12], Nuha [13] and Zhou [27] use sigmoid activations. The sigmoid activation has derivative which has maximum value of $\frac{1}{4}$. This can cause the gradients to vanish during back-propagation.

This study aims to compare a deep auto-encoder trained by back-propagation with RBM pre-training to an auto-encoder of the same architecture trained directly with by back-propagation. It will try to address the problem of vanishing gradients by using ReLU activations. It will try to push the number of hidden layers in the auto-encoder further than the previous studies. Hinton and Tan used 7 hidden layers, Zhou 1 to 3, and Nuha just 1.

2 Network Architecture and Datasets

The auto-encoders are first compared on the MNIST dataset. This dataset consists of hand-written digits represented as gray-scale images with resolution of 28 by 28 pixels. It has 60000 training images and 10000 testing images. The comparison of the auto-encoders is done on the 10000 testing images.

The auto-encoders are fully connected and symmetric from the middle layer. Each auto-encoder has the same architecture, 784–512-256–128-64–32-64–128-256–512-784, which has 10 hidden layers.

With this architecture 3 auto-encoders are trained:

- **RBM + sigmoid** RBM pre-trained auto-encoder which has sigmoid activations.
- **sigmoid** Auto-encoder which is not RBM pre-trained and has sigmoid activations.
- **ReLU** Auto-encoder which is not RBM pre-trained and has ReLU activations.

The hidden layer with 32 units is called bottleneck. The part of the auto-encoder before the bottleneck is called encoder and the part after is called decoder. The auto-encoder in this study maps 784-dimensional space into 32-dimensional space.

2.1 RBM Pre-training

The restricted Boltzmann machine is a stochastic neural network, which can learn the probability distribution of data. It has visible units and hidden units, where each visible unit corresponds to a dimension of the input data and each hidden unit is latent variable.

It is a special case of the Boltzmann machine in which the visible units only depend on the hidden units, and the hidden units only depend on the visible units.

The probability of visible values $\boldsymbol{v}$ and the hidden features $\boldsymbol{h}$ is

$$p(\boldsymbol{v}, \boldsymbol{h}) = \frac{1}{Z} e^{-E(\boldsymbol{v}, \boldsymbol{h})} \tag{1}$$

$$Z = \sum_{\boldsymbol{v}} \sum_{\boldsymbol{h}} e^{-E(v,h)}, \tag{2}$$

where E is the energy function.

The RBMs used in the pre-training algorithm have continuous visible units and discrete hidden units. This type of RBM is known as Gaussian-Bernoulli RBM [28] and its energy function is

$$E(\boldsymbol{v}, \boldsymbol{h}) = \sum_{i}^{V} \frac{(v_i - a_i)^2}{2\sigma_i^2} - \sum_{j=1}^{H} b_j h_j - \sum_{i=1}^{V} \sum_{j=1} \frac{v_i}{\sigma_i} w_{ij} h_j, \tag{3}$$

where $W \in R^{VxH}$ is the weight matrix, $\boldsymbol{a} \in R^V$ are the visible biases, $\boldsymbol{b} \in R^H$ are the hidden biases, V is the number of visible units, and H is the number of hidden units. Due to the conditional independence assumption in the RBM, the visible and hidden units can be updated simultaneously according to

$$p(v_i|\boldsymbol{h}) = \frac{1}{\sigma_i \sqrt{2\pi}} \exp - \frac{1}{2\sigma_i^2} \left(v_i - a_i - \sigma_i \sum_j w_{ij} h_j \right)^2 \tag{4}$$

$$p\left(h_j|\boldsymbol{v}\right) = \frac{1}{1 + \exp - \left(\sum_i \frac{v_i}{\sigma_i} w_{ij} + b_j \right)}. \tag{5}$$

For each layer of the encoder part a RBM is trained with visible units representing the input data for the layer and the hidden units the activation. Once the RBM is trained the activation probabilities of the hidden units are calculated for each input data-point, and these probabilities become the input data for the next RBM.

Finally the auto-encoder is initialized by setting the weights, and biases of the encoder part to the weights and the hidden biases of the corresponding RBM, and the weights and biases of the decoder part are set to the transposed weights and visible biases of the corresponding RBM.

In the last step the auto-encoder is trained with the error back-propagation algorithm.

2.2 Training of RBMs

Restricted Boltzmann machines are trained by minimizing the negative log-likelihood of the data, given the parameters of the RBM,

$$-\frac{1}{N} \mathcal{L}(\boldsymbol{\theta}) = \sum_{n=1}^{N} \log \sum_{\boldsymbol{h}} \frac{1}{Z} \exp - E\left(\boldsymbol{v}^{(n)}, \boldsymbol{h}\right), \tag{6}$$

where N is the size of the input data, and $\boldsymbol{v}^{(n)}$ is the nth sample of the input data. To minimize this function the derivative with respect to each parameter has to be calculated,

$$-\frac{1}{N} \frac{\partial}{\partial \theta_i} \mathcal{L}(\boldsymbol{\theta}) =< -\mathbb{E}\left[-\frac{\partial}{\partial \theta_i} E(\boldsymbol{v}^{(n)}, \boldsymbol{h}) | \boldsymbol{v}^{(n)} \right] + \mathbb{E}\left[-\frac{\partial}{\partial \theta_i} E(\boldsymbol{v}, \boldsymbol{h}) \right] >_{n=1}^{N}, \tag{7}$$

where $\mathbb{E}\left[f(x,y)|x\right] = \sum_y p(y|x)f(x,y)$, and $<\bullet>$ is average. Since the two expectations are computationally difficult to estimate contrastive divergence is used to approximate the derivative,

$$-\frac{1}{N}\frac{\partial}{\partial\theta_i}\mathcal{L}(\boldsymbol{\theta}) =< \frac{\partial}{\partial\theta_i}E(\boldsymbol{v}^{(n)}(0),\boldsymbol{h}^{(n)}(0)) - \frac{\partial}{\partial\theta_i}E(\boldsymbol{v}^{(n)}(k),\boldsymbol{h}^{(n)}(k))>_{n=1}^{N} \tag{8}$$

where $\boldsymbol{v}^{(n)}(k)$ are the visible units sampled from $\boldsymbol{h}^{(n)}(k-1)$, and $\boldsymbol{h}^{(n)}(k)$ are the hidden units sampled from $\boldsymbol{v}^{(n)}(k)$. The visible units $\boldsymbol{v}^{(n)}(0)$ are set to the values of the nth data point.

Following [3], $k = 1$ and the values of the visible and simple units are not sampled from the RBM, but instead the values of the hidden units are set to the activation probabilities and the values of the visible units are set to the mean value of the Gaussian distribution. The standard deviation is set to 1 for each visible unit, and only the weights and biases are updated.

3 Methods

Each RBM was trained using the AdaMax algorithm with the default parameters and a batch size of 250. The initial parameters of the weights of the RBMs were drawn from Gaussian distribution, $N\left(0, \frac{2}{V+H}\right)$, (Xavier) and the biases are set to zero.

The first two RBMs (784×512 and 512×256) were trained for 400 iterations, the third (256×128) for 600, fourth (128×64) 1000, and the last (64×32) for 3000. The error function used is the mean squared error,

$$\mathcal{E} = \frac{1}{NV}\sum_{n=1}^{N}\sum_{i=1}^{V}\left(y_i(n) - \hat{y}_i(n)\right)^2, \tag{9}$$

where N is the number of data points, $y_i(n)$ is the nth target, and $\hat{y}_i(n)$ is the output of the network for the nth input.

Then the auto-encoders were trained with the AdaMax algorithm with default parameters, for 20 iterations with batch size of 32. The auto-encoder **RBM + sigmoid** was initialized to the weights of the RBMs, and the other two auto-encoders were initialized with the Xavier initialization drawn from Gaussian distribution. The ReLU units have a maximum value of 1.

For the RBMs was used custom implementation of the AdaMax algorithm and the calculation of the derivatives. For the fine tuning of the auto-encoders was used TensorFlow 2.4.

4 Results

Figure 1 shows the training error for each auto-encoder. The network **RBM + sigmoid** is trained starts from the lowest error, due to the pre-training, but the error declines slower than **ReLU** and converges at higher error. The auto-encoder **sigmoid** starts at much higher error and the error declines very slow. It would require a lot more iterations to achieve good performance.

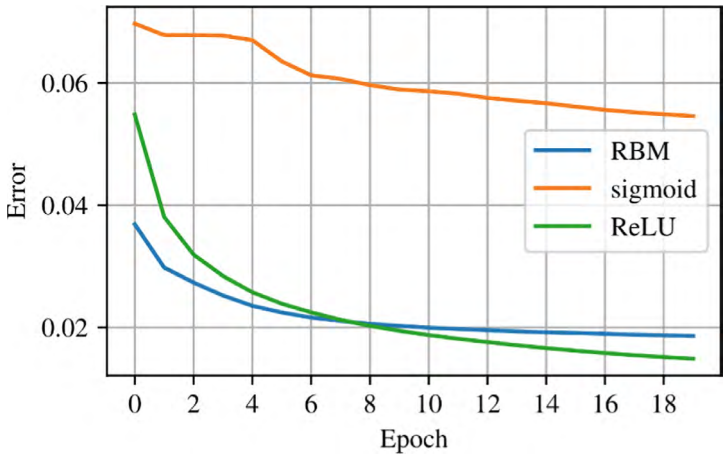


Fig. 1. Training error of the auto-encoders - RBM + sigmoid (Blue), sigmoid (Orange), and ReLU (Green)

Figure 2 shows 8 randomly chosen samples of the MNIST dataset compressed and reconstructed with each of the auto-encoders. Best performing is the **ReLU** auto-encoder, and the worst is the **sigmoid** auto-encoder. The pre-trained auto-encoder (**RBM + sigmoid**) has similar performance as the **ReLU**.

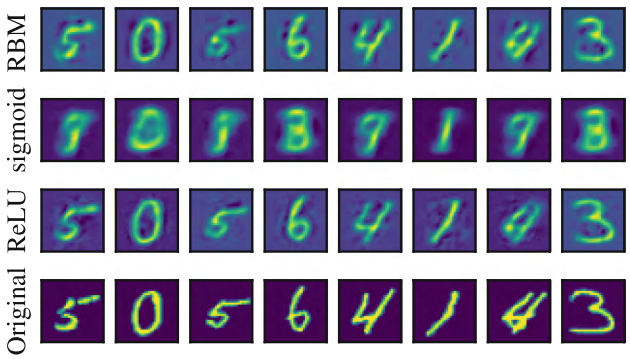


Fig. 2. An example of the reconstruction error of 8 samples of the MNIST dataset.

5 Conclusion

The results showed that the RBM pre-training significantly improves the performance of the auto-encoder when using sigmoid activations, however the benefits of the ReLU activation offset the benefits of the RBM pre-training. The **ReLU** auto-encoder performed better than the **RBM + sigmoid** when trained the same number of iterations, but didn't need pre-training which is quite expensive. The pre-training required approximately $4.93 * 10^{12}$ multiplications.

The reason that the ReLU activation is better is that it has derivative of exactly 1 or 0, which helps with the problem of vanishing gradients. The maximum value of the sigmoid derivative is $\frac{1}{4}$ which causes the network to either be impossible to train or take too long time when many layers are used.

Using ReLU activations and Xavier initialization outperforms the RBM pre-training. Provided the additional computational cost, the pre-training becomes inefficient.

In future research can be explored whether the RBM pre-training can improve the performance of the convolutional auto-encoders.

Acknowledgement. The experiments described in this paper became possible thanks to the computing resources and technical support provided by UNITe project: https://unite-bg.eu/.

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Educational Program for the Development of Digital Competencies of Teachers of Social Sciences in Secondary Vocational Education

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Abstract. The aim of the paper is to point out to a new educational program, which was created as one of the outputs of the TAČR ÉTA project (project number TL01000192) at the Czech Technical University in Prague, Masaryk Institute of Advanced Studies within the research grant of the Czech Republic [1]. The educational program develops the digital competencies of teachers, is focused on working with new technologies and the application of digital technologies in the educational process.

Keywords: Educational program · Digital competencies · Digital technologies · Teachers · Education · Research

1 Introduction

As a part of his creation, we relied on theoretical and research analyses, which showed that technology can be helpful in preparing teachers for lessons, helping in didactic transformation, interpretation and modernization of educational content, enrich cooperation and communication and integrate more school partners, especially parents of pupils. We were also aware that the uncritical or uneducated use of digital technologies can negatively affect the effectiveness of the educational process. In this sense, we have adopted the initial research knowledge for the creation of the program that social science educators know how to teach digital teaching even less than their colleagues and need support in a wide range of competencies.

In 2019, the Ministry of Education, Youth and Sports in the Czech Republic published the Framework of Digital Competences of Teachers, which is based on the Czech translation of the European Framework of Digital Competences of Teachers [2]. The framework of teachers' digital competencies in a structured and comprehensive form that shows what today's teacher should know and be able to do when using digital technologies. It focuses mainly on pedagogical competencies and provides insight into how these competencies are influenced by the possibility or necessity of using digital technologies in teaching. The framework defines 22 competences covered in six areas: professional involvement, digital resources, teaching, digital assessment, pupil support, support for pupils' digital competences [2].

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 705–713, 2022.
https://doi.org/10.1007/978-3-030-85540-6_89

2 Conception of the Educational Program

When creating the program, we have also accepted the current assumption that digital literacy and digital competencies are not purely professional components of education but have become part of key competencies in a digitally transformed society [3]. Today, **the development of these competencies** is no longer a requirement exclusively applied for teachers of vocational subjects. In the same way, because of the planned revisions of the ICT curriculum in the RVP, teachers of social science subjects should be equipped with appropriate digital competencies so that the digital competencies of pupils are applied in their lessons as well. Similarly, in order to create the program, it has proved essential to try to use the insight of social science teachers into the wider social context in order to increase their potential for using technology in a creative and critical way.

Aware of the above principles and based on **theoretical and empirical analyses** e.g. [4–6] the goal of the program was formulated: The aim of the educational program is to develop digital competencies of teachers of social sciences in secondary vocational schools so that they can creatively and critically integrate digital technologies into teaching, cooperation and communication with pupils, parents, colleagues and school management. To motivate them to use digital technologies in teaching, to lead them to identify their own needs and to use digital technologies for their professional development. Overall, the program is designed so that teachers of social sciences are able to implement digital technology in teaching, use it for their professional development and be able to prepare students for life in the world of digital technologies. The program is not only focused on the user mastery of technologies for teaching but is didactically integrated into the teaching needs of teachers of social sciences.

The curriculum is inspired by several sources, the European Framework of Digital Competencies for Citizens DigComp 2.1 [7], the European Framework of Digital Competencies for Educators DigCompEdu [8] and the results of revisions of the ICT curriculum in framework educational program (RVP) [9]. At the same time, the conclusions of the research, which we carried out on a sample of 2018 secondary school teachers, were reflected its creation e.g. [10–12]. The research showed that the least developed **digital competencies** in teachers fell into the field of digital teaching, i.e. into area No. 3 (Teaching and Learning) contained in DigCompEd. Based on further analyses of data from the research survey, the topics for the creation of modules in the educational program were adjusted, especially on the basis of those items in which the answers were insufficient, and we see a digital divide in them. The outputs from the analysis of the content of study programs for teacher training in the Czech Republic were also incorporated [5]. **The educational program** was an experimental material, which was optimized to the final form. Optimization and finalization were performed after incorporating the outputs from the guided interviews with experts, after the implementation of workshops, including a questionnaire tool, and after verification of the educational program in pedagogical practice. At the end of the whole process, an **international scientific conference** titled Development of Digital Competencies of Secondary School Teachers as a Priority of Contemporary Education was held [13].

3 The Process of Creating an Educational Program

The Preparatory Phase Took Place in Years 2018–2019. The design of the educational program was preceded by the study of professional literature, active participation in international scientific conferences, teaching stays, workshops, workshops and team publishing activities. The subject of discussions was the expert opinions of innovative pedagogues and practitioners on teaching implemented using digital technologies. The acquired knowledge and inspiring ideas from these active participations were used to construct an educational program.

The proposal was also preceded by an analysis of the content of courses for further education of pedagogical staff, resp. sub-subjects of accredited study programs for the training of teachers focusing on digital competences with an emphasis on the target group of secondary vocational school teachers [5]. We have come to the conclusion that educational institutions do not focus in their teaching on new technologies as a support for the educational process, currently already commonly used in the educational reality. We also found that there is a lack of systematic support from educators for the development of their digital competencies.

The Implementation Phase in 2019–2020 Followed. Based on the analysis of digital frameworks [2, 7, 8] and the first research data [3, 4, 10], a draft educational program was compiled. The proposal aimed not only at teachers' ability to work with digital technologies, but also at recognizing their teaching potential. The program was continuously processed into a template with a modular structure provided by the customer of this research result, application guarantor No. 1. (National Pedagogical Institute of the Czech Republic, formerly the National Institute for Education). After the analysis of the e-learning Standard [14], it was decided that the program will be processed so that its modules can be transferred to the LMS Moodle study environment.

Based on further analyses of data from the research survey [10, 11], the topics for the creation of modules in the educational program were adjusted, especially on the basis of those items in which the answers were insufficient and we see a digital divide in them. Following this, we focused in the program on areas in DigCompEd [2, 7, 8] - education and learning, specifically on the competence of teachers for e-learning, the use of technology for online teaching, to support new methods and forms of teaching, cloud learning and online learning. Line cooperation and collaboration.

An evaluation tool was created to capture the suggestions for the modification of the program, and the program was piloted with teachers, in cooperation with the application guarantor No. 2, SPŠE Ječná, Prague [12]. A draft version of the content of the document was also provided for comments to the representatives of the application guarantors. Comments and suggestions from the pilot, from the evaluation tool and from the suggestions of the representatives of the application guarantors were subsequently incorporated into the educational program. At this stage, the program was handed over to the internal approval processes of application guarantor No. 1 (National Pedagogical Institute of the Czech Republic).

Furthermore, in June 2020, in cooperation with the application guarantor No. 2 (SPŠE Ječná, Prague), a workshop for teachers was organized, which was designed to share experiences in the field of developing digital competencies of teachers of social

sciences. The shared platform enabled the exchange of experiences, ideas, examples of inspiring practice. Part of the workshop was the identification of hitherto unaccounted for needs of teachers of social sciences in the field of digital competence development with a focus on the goals, indicators of program performance and parameters for its implementation. The acquired knowledge was used in the finalization of the educational program [12].

At the end of the whole process, an international scientific conference entitled **Development of Digital Competences of Secondary School Teachers as a Priority of Contemporary Education** was held in October 2020 [13]. The conference presented interesting, valuable and inventive contributions from experts in the field of technical and social sciences, ICT didactics, representatives of application guarantors and teachers of social sciences. The topics were focused on the presentation of the prepared educational program, the results of research surveys determining the digital competencies of secondary school teachers, the project activities of schools and the digital competencies of teachers. Furthermore, partial outputs of the project were presented at the conference [12]. The stimulating discussion at the end of the conference contributed to more detailed recommendations for the educational program. All information, topics and documents can be found on the created special conference website [13].

After all the above activities and activities, a modularly conceived educational program called the Program for the Development of Digital Competences of Teachers of Social Sciences in Secondary Vocational Education was finalized. **The educational program contains modules** that arose from professional analyses, research, discussions with experts and from ongoing project activities. In particular, they address this key issue [12]:

- E-learning and online communication tools.
- Digital competences and digital technologies.
- Innovative didactic tools in teaching and interactive technologies.
- Cloud applications and other services in the school environment.
- Digital technologies in teaching and school management.
- Searching for information on the Internet and security.

Didactic materials were also created for the educational program according to the three-phase model of the E-U-R learning process as its methodological support. First, we focused on studying the concept of key competencies in the framework educational programs (RVP) of secondary vocational education with a focus on the competence to use the means of information and communication technologies and work with information. Didactic materials were continuously expanded and modified on the basis of the results of a research survey [4, 6, 10, 11] and modified topics of the educational program into individual modules. The materials are prepared so that they can be transferred to the e-learning environment as an electronic study support and finally adapted for three-level difficulty according to the educational program, which has a modular character also in three levels of difficulty [12]. Didactic materials will be published separately as a methodological support of the educational program.

4 Characteristics of the Educational Program

The educational program is called **Development of digital competencies of teachers of social sciences in secondary vocational education.** The educational program is primarily intended for deepening professional qualifications, specifically for deepening the digital competencies of teachers (study to deepen professional qualifications). The target group is teachers of social science subjects at secondary vocational schools. In addition, it can also be attended by other teachers, school leaders and representatives of non-teaching professions in education (school psychologists, special pedagogues) and teaching assistants.

The graduate of the educational program is able to integrate digital technologies into the teaching process and use them for their professional development. He is able to use e-learning and online communication tools and apply digital competencies to teaching so as to support their development in their students. He orients himself in the advantages and limits of the use of digital technologies and manages innovative didactic tools and interactive technologies suitable for teaching. He is able to use various functions of cloud applications for teaching management, sharing resources and content, collaboration with colleagues and school management. It masters various tools for searching for information on the Internet and applies them to teaching and students' independent work. He orients himself in the risks of digital technologies and uses them safely and critically [5, 12].

The content of the educational program is divided into modules. Each module has set performance indicators, which are developed in three levels of difficulty:

Level I. - A1 + A2 (novice + discoverer; low - basic knowledge and use).
Level II. - B1 + B2 (practitioner + expert; effective - strategic knowledge and use).
Level III. - C1 + C2 (leader + pioneer - critical and innovative knowledge and use).

General development objectives of the program [12]:

- To develop the digital competencies of teachers of social sciences in secondary vocational schools so that they can creatively and critically integrate digital technologies into the teaching process, cooperation and communication with students, parents, colleagues and school management.
- Motivate teachers to use digital technologies in teaching and lead them to the insight that, when used appropriately, these technologies can be a systemic tool for teaching in secondary vocational education.
- Guide teachers to be able to identify their needs and reach their maximum within the chosen target level (A1-C2).
- Encourage teachers to reflect on how to use digital technologies appropriately and effectively for their professional development.

Specific sub-objectives [12]:

- Teach teachers to use e-learning and online communication tools for teaching.
- To develop skills and abilities to use digital technologies in the teaching process, preparation for teaching, communication and cooperation with pupils, parents, colleagues and school management.

- Motivate teachers to use and support their students' digital competencies.
- To orient teachers in the advantages and limits of the use of digital technologies.
- To teach teachers to use innovative didactic tools and digital resources.
- Teach teachers to use cloud application software for teaching, resource and content sharing, collaboration and communication.
- To support teachers in the ability to search for information on the Internet and in their application to teaching and students' independent work.
- Orient teachers in the risks of using digital technologies.

The content of the program is based on the European framework of digital competencies of teachers and reflects the educational strategy of the Czech Republic - the Strategy of Digital Education until 2020 [15] and the Strategy of Educational Policy until 2030 + [16]. It also takes into account the revision of the framework educational program (RVP) for secondary vocational education and the new concept of the ICT curriculum, which requires that the development of pupils' digital competences be included in all subjects, including the social sciences [17, 18].

Content of modules in relation to DigCompEd [12]:

- E-learning and on-line communication tools: focus mainly on development according to DigCompEd: professional involvement, support of pupils' digital competencies.
- Digital competences and digital technologies - focusing primarily on development according to DigCompEd: teaching, support for pupils' digital competencies, digital assessment, pupil support.
- Innovative didactic tools in teaching and interactive technologies - focusing primarily on development according to DigiCompEd: digital resources, teaching.
- Cloud applications and other services in the school environment - focusing primarily on development according to DigCompEd: digital evaluation, professional involvement, digital resources.
- Digital technologies in teaching and school management - focusing primarily on development according to DigCompEd: professional involvement and teaching, support for digital competencies of students, digital assessment, support for students.
- Searching for information on the Internet and security: focusing primarily on development according to DigCompEd - digital resources, support for students' digital competencies.

Methodical Teaching Methods. The educational program is conducted in the form of blended learning (tutored blended learning teaching), combines an introductory one-hour seminar, full-time teaching, webinar and e-learning. Emphasis is placed on guided self-study of study materials (digital teaching resources and electronic study materials), which have been specially adapted to the needs of individual educational modules. The program can be completed as a whole or individual modules (8 hrs) can be completed based on the professional needs of the teacher. The optimal trajectory is determined (module 1 - module 3, then module3/module4/module5/module6). Each module has set indicators of fulfilment of expected learning outcomes and parameters for evaluating learning outcomes.

Learning outcomes - the graduate of the educational program is able to [12]:

- Develop your own digital competencies and reach their maximum at individual levels.
- Develop students' digital competencies.
- Work with digital technologies in teaching and other activities related to the demands of the profession.
- Choose a suitable technology for teaching and assess its educational potential.
- Recognize and use the learning potential of digital technologies in the areas of classroom management, new methods and forms supporting cooperation and joint learning of students.
- Critically evaluate whether the technology used in teaching is meaningful and effective and leads to learning objectives.
- Master the preparation for the lesson using digital technologies.
- Monitor trends in the development of emerging educational technologies and orient themselves in them.
- To develop students' creative and critical thinking in relation to the role of digital technologies in school and society.
- To be motivated to participate in further professional education in the field of new methods and forms of learning.
- Have a critical and creative relationship with new technologies and digital education.

The entire educational program, including detailed content of the curriculum of individual modules, annotations defining the objectives of modules, hourly allowances, teaching organization, entry requirements for participants, expected learning outcomes, teaching procedures, methods of completing modules, teaching evaluation of teaching results, compulsory and recommended literature can be found in the collective monograph [12]. **The collective monograph** which was created as one of the outputs of the TAČR ÉTA project (project number TL01000192) at the Czech Technical University in Prague, Masaryk Institute of Advanced Studies within the research grant of the Czech Republic [1, 12].

5 Conclusion

The practical benefit for pedagogical practice is, based on research, an optimized educational program. This program is open and can be adapted to any area of education in the future. The educational program was experimental material, which was optimized for the final form. The optimization and finalization were performed on the basis of the preparatory and implementation phase of the process of creating the educational program. If we summarize all the findings, we come to the conclusion that the obtained results influenced the optimization of the educational program. It is certain that due to the dynamic development of technologies, the educational program will be continuously updated and will approach the needs of the pedagogical public, the needs and possibilities of individual schools, **new technologies** and the focus of subjects. The identification of knowledge and user digital competencies of teachers made it possible to create an educational program so that teachers can further educate themselves and develop their competencies according to their current level. This ensures continuity of

education and support for teachers, who can also gain the support of other teachers of their subject and increase their motivation for the involvement of digital technologies in teaching [11]. For example, based on examples of good practice. This is in line with the results of the study, see [4], according to which motivation and support are among the important factors facilitating the use of digital technologies in teaching among social science teachers. The purpose of **innovation in education** is to develop teachers' digital competencies in activities related to digital technologies and to introduce new methods and forms of education. Teachers' digital competences are key to streamlining existing teaching practices and meeting learning objectives [19–21]. We hope that the prepared educational program and didactic materials will contribute to their development.

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Using Neural Network for Predicting the Load of Conveyor Systems

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Abstract. Usually the purpose of a conveyor is not only to transfer the load to its destination but also to make a buffer that allows storing some number of products before the accepting side is available. Compromise between the throughput and storage density gets harder when the load varies during operation. The conveyour's efficiency could improve if it can predict the load. Here we present a novel method for finding load distribution patterns in conveyor systems using neural network in order to predict the load and to automatically adapt the conveyor behavior. We used simulated input load and output loads for the conveyour to train a neural network. The experimental results showed that the network is able to predict the input and output loads with high accuracy.

Keywords: Conveyor systems · Neural network · Load prediction · Systems engineering

1 Introduction

Nowadays conveyor systems play more and more important role in material handling automation found in many areas such as manufacturing, goods storage, automated stores, airports etc. The number of tasks that a conveyor is expected to do and their complexity are getting higher. Parallel to that the price of the conveyor components gets lower and the market gets bigger.

Often the source of the loads is third party system or conveyor that would not comply with the communication protocol implemented in the linear part.

The proposed method considers the zones of the conveyor as software agents having its own goal to improve the characteristics of the whole system.

The conveyor can employ different techniques to optimise the speed of the transportation depending of the average number of input packages and the average number of output packages.

The purpose of this task is to predict the average number of input and output packages depending on a time point $t \in \mathcal{T}$,

$$\text{Pred} : \mathcal{T} \mapsto R^2 \tag{1}$$

where $\mathcal{T}$ is the set of all time points.

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 714–719, 2022.
https://doi.org/10.1007/978-3-030-85540-6_90

The function Pred is modeled by a feed forward neural network (FFNN), where the input will be the time point t and the output will be the expected input load and the expected output load, $y \in R^2$.

1.1 Figures

The network, ffnn, is trained with a dataset, $D = \{(t, l)_n\}$, where $t \in \mathcal{T}$, $y \in R^2$, and $n = 1..N$. Each time point, t, is described by different features:

- hour, 0..23
- day of week, 0..6

The error function is the mean squared difference:

$$\varepsilon = \frac{1}{N}\sum_{n=1}^{N}(l_n - \text{ffnn}(t_n))^T(l_n - \text{ffnn}(t_n)) \tag{2}$$

All vectors are assumed to be column vectors. The neural network will have one hidden layer, with ReLU activations and output layer with linear activations.

1.2 Simulation

The network is trained with simulated data. The simulation is done for each week independently.

1.3 Generating the Number Input Packages

The probability of input packages given a day of the week, d, is

$$p(L_d|d, L) = \text{Pois}(f_d(d, L_w)) \tag{3}$$

and the probability of input packages given an hour of a day, h is

$$p(L_h|h, d) = \text{Pois}(f_h(h, L_d))) \tag{4}$$

where Pois is the Poisson distribution and L_w, for load, is the expected number of packages per week. The function f_d is

$$f_d(d, L_w) = w_0 + \sum_{k=1}^{K_d} w_k N_{IT}(d, \mu_k, \sigma_k) \tag{5}$$

$$\sum_{d} f_d(d, L_w) = L_w \tag{6}$$

Similarly the function f_h is

$$f_d(h, L_d) = w_0 + \sum_{k=1}^{K_h} w_k N_{IT}(h, \mu_k, \sigma_k) \tag{7}$$

$$\sum_{h} f_d(h, L_d) = L_d \tag{8}$$

The function N_{IT} is the integral of a truncated Gaussian function,

$$N_{IT}(x, \mu, \sigma) = \int_{x}^{x+1} N_T(t, \mu, \sigma)dt \tag{9}$$

$$N_T(x, \mu, \sigma) = \begin{cases} N(x, \mu, \sigma) \text{ if } x \in [a, b] \\ 0 \qquad\qquad \text{otherwise} \end{cases} \tag{10}$$

where a is 0 and $b = 6$ in f_d, and $b = 23$ in f_h.

The weights w_i, where $i = 0..K$ are set in advance as a parameters to the simulation. However, to satisfy constrains 6, and 8 instead of setting w_i directly the simulation require to set the weight proportions $\hat{w}_i$ instead and then transforms them according to

$$w_k = \frac{\widehat{w}_i}{\sum_{k=1}^{K} \widehat{w}_i + N\widehat{w}_0} L, \quad k = 1..K \tag{11}$$

where k is the number of components, N is the number of days for f_d and the number if hours for f_h, and L is L_w for f_d and it is L_d for f_h.

1.4 Generating the Number of Output Packages

The number of output packages is generated after the number of input packages, i_t, is generated for each hour. For each hour h_t is generated a value s_t which is a delay. It mean after how many hours it has been picked. Then the output packages for each hour, o_t, can be evaluated by:

$$o_t = \sum_{t'} (h_{t'} + s_{t'} == t) * i_{t'} \tag{12}$$

The value s_t can be generated by a truncated Gaussian distribution.

1.5 Parameters

The simulations will have parameters which need to be set manually:

- L_w - the expected number of packages to be processed by the conveyor belt for a week.
- K_h - how many peaks there are per day.
- K_d - how many peaks there are per week.
- $\hat{w}_i$ - the weights for each truncated Gaussian component including the background $\hat{w}_0$
- θ - These are all the parameters of the truncated Gaussian components.
- θ_s - The parameters for generating s_t.

Also all of the weights w_k will have to be generated before the simulation and will have the same values for the entire simulation. It is also possible to generate the parameters θ but that may be simpler to be set manually.

2 Methods

The code is implemented in Python 3.6.8 using the libraries:

- numpy - 1.19.1
- tensorflow - 2.4.1
- scipy - 1.5.4

2.1 Simulation

For the experiments 3 datasets were used:

- training set - 12 weeks long
- testing set - 5 weeks long
- validation set - 2 weeks long

All of the datasets were generated using the parameters, described in Table 1.

Table 1. The parameters for the simulated datasets

Parameter	Value
L_w	10000
$\mu_i, i = 1..2(f_h)$	10, 15
$\sigma_i, i = 1..2(f_h)$	1, 2
$\hat{w}_i, i = 0..2(f_h)$	1, 10, 5
$\mu_i, i = 1(f_d)$	2
$\sigma_i, i = 1(f_d)$	1
$\hat{w}_i, i = 0..1(f_d)$	1, 5
μ_s	3
σ_s	0.5
$(\min_s, \max_s)$	(0, 4)

2.2 Neural Network

The neural network is initialized by the Xavier algorithm [1] using Gaussian distribution. It is trained by the Adamax algorithm [2] for 1500 iterations for the network with 5 and 10 hidden units and 10000 iterations for a network with 50 hidden units. The learning rate is $1 * 10^{-3}$, $\beta_1 = 0.9$, and $\beta_2 = 0.999$. The activation of the hidden layer is ReLU and the output layer is linear.

3 Results

Figure 1 shows the training error, solid line, and testing error, dashed line, for a network with 5 hidden units, shown in green, and a network with 10 hidden units, shown in red. Both networks converged at error around 2470 and have small difference between training and testing set, of around 230.

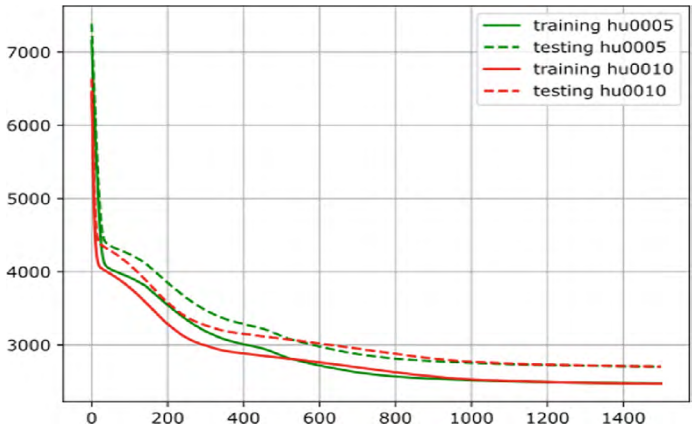


Fig. 1. Training and testing error for neural network with 5 and 10 hidden units.

Figure 2 shows the training error, solid line, and testing error, dashed line, for a network with 50 hidden units. The network converged at error around 1600 training error and 1761 testing error, with difference of 160.

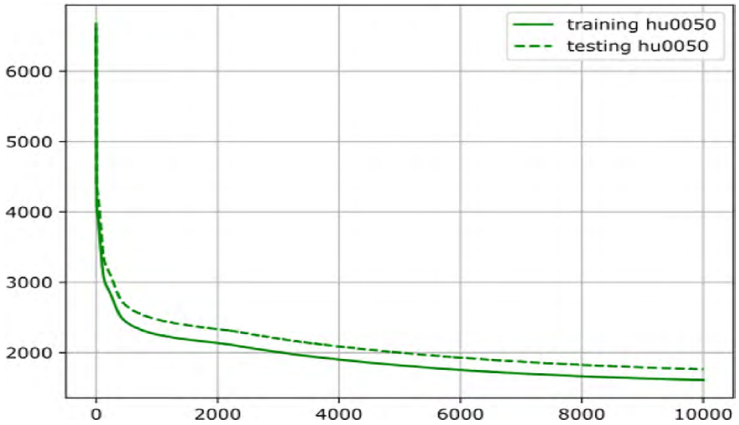


Fig. 2. Training and testing error for neural network with 5 and 10 hidden units.

Figure 3 shows the input packages to the conveyor on the top and the output packages of the conveyor at the bottom for a period of two weeks. The dataset shown, with the

black solid line, is the validation data. The network prediction is shown with dashed green line. The plot shows that the network successfully modeled the peaks of input and output packages for each day of the two week period.

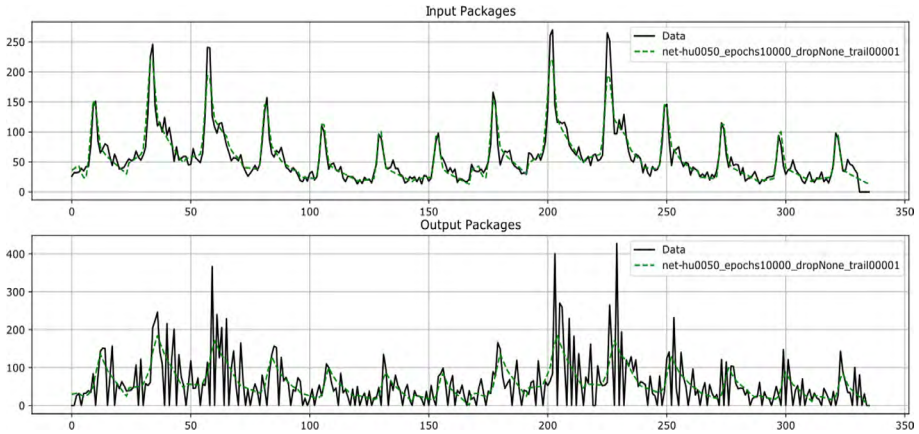


Fig. 3. A plot of the simulated validation data, in black solid line, with the predicted load by the network with 50 hidden units.

4 Conclusion

The networks with 5 and 10 hidden units produced significantly higher errors than the networks with 50 hidden units, which successfully modeled the peaks of the input and the output packages of the conveyor. The successful modelling of the input and output loads will allow the conveyor to employ more appropriate strategy to improve it's efficiency.

It is possible to expand the representation of the time to include a day of the month to allow it to capture dependencies between the workload and the part of the month.

The contributions of the paper are useful for companies engaged in engineering activities for the construction of systems including conveyors for automated warehouses, sorting centers, airports, shops, various manufacturing plants, etc., allowing them to reduce their total cost and make them more intelligent.

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BPM Model of Design Management Under a Design Thinking Approach to Implement New Products in Textile SMEs

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Abstract. Textile SMEs differ from others by their ability to generate garment designs according to current trends, this is the main competitive advantage of an SME in the field, however, design management refers to management problems from within every company. It seeks to establish a model that can improve the times, costs and satisfaction of workers who collaborate within the design management of textile SMEs, using a BPM management model under the Design Thinking approach, changing the focus of the Design Thinking tool to seek solutions within business problems through the BPM structure and its life cycle A case study was carried out for the validation of the model in a textile SME in Peru, the main results obtained were the improvement of times and costs in management design by 9% and 7%, respectively.

Keywords: BPM · Design thinking · Textile · Management model

1 Introduction

Currently, Peru's economy is sustained thanks to the presence of MIPYME-type companies (Micro, small and medium-sized companies), since they represent more than 95.5% of the total number of companies in the country [1] at the same time they provide about 50% of jobs not only in Peru, but in America. Peru represents a particular case within textile companies, since this sector has always been one of the biggest drivers due to the high demand for importing garments or the outsourcing of jobs due to the cheap labor it represents. However, this has been decreasing, mainly due to problems such as the adoption of technology in the processes, labor informality, low investment, low quality and logistical problems, all this considering that 98% of companies in the sector are MSMEs [1]. The future of MSMEs depends on the response that they have towards their clients with respect to their expectations and to achieve this they must focus on the improvement of key business processes [2].

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 720–728, 2022.
https://doi.org/10.1007/978-3-030-85540-6_91

These processes encompass common factors that prevent their optimization, within which technology and innovation are identified as the main ones. Currently, in the new trends there are innovative solutions to promote efficiency in this type of process, where technology plays a very important role. It is known about the direct use of technology with a 3D scan of the human body, focusing this information towards the manufacture and design, with the aim of solving the problems of consumers when buying and consuming in stores through the web [3].

This research seeks to structure a design management model in a textile company, based on a BPM methodology under a Design Thinking approach. In terms of results, it is expected to be able to obtain a better response in the implementation by the collaborators, have a cost reduction of 5% and improve the times compared to other models by 5%. Likewise, employee satisfaction is expected at the time of implementation, since it is known that job changes impact their attitude, due to fear of change. In this way, the model adapts to the business challenges of the day-to-day sector, which are in seeking economic and agile solutions so as not to stop operations. The following article presents the phases and results of the proposal mentioned in 6 sections; Sect. 2 presents the state of the art on definitions and recent research on the topics; Sect. 3 covers the contribution generated achieved through the management of the state of the art and innovation; Sect. 4 shows the validation process quantitatively; Sect. 5 comments on the discussion of the results and Sect. 6 will delve into the conclusions of the research and future research that could be carried out.

2 Estate of the Art

2.1 Management Models

The management models have a set of steps aimed at improving the competitiveness and efficiency of the processes through established processes, always taking into account the quantitative data that can be diagnosed. Currently, there are methods focused on agile development, which allow team collaboration and improve performance, taking into account the collection of information; this is important due to the environment in which the sector currently operates, since optimal times and teamwork are needed to help companies obtain a sustainable competitive advantage [4–6]. These models contain procedures for making improvements that can contribute to companies, especially those in the MSME sector, where they show us the need to guide these steps and/or systems towards the central processes for the development of a solution, with extraordinary results for the search for problems and their respective solutions [7–9].

2.2 Business Process Management Based on Management Models

It is a management discipline composed of methodologies and technologies that aims to improve an organization's processes, it has characteristics that must prevail for a correct implementation, and that must be taken into account together with the components that intervene, these are, the holism, context, technology, simplicity and joint understanding, understanding these concepts allows people to correctly apply BPM, since with this they

can adapt the methodology to their reality [10]. BPM has a modeling language, called BPMN, which allows a simple way to understand business processes [10–12]. All this is developed in stages, which can be measured and are called the BPM life cycle, it consists of: Diagnosis, Modeling, Implementation, Execution and Measurement and Evaluation, this structure of steps guarantees a correct execution of activities segmented in order, which enhances the understanding of what is being studied [12, 13].

2.3 Design Thinking Based on Management Models

Innovation consists of the use of knowledge by applying new concepts, services and practices to a certain issue, this innovation focused on products and the business environment, is obtained through the study of the impact of the ability to apply forms of design thinking, which has Design Thinking as a strategy [14, 15]. This allows the generation of new creative approaches to carry out a feasibility analysis of the use of Design Thinking as a facilitator to increase the integration of stakeholders in this process [16].

3 Input

3.1 General

Main Idea. The contribution consists in structuring the phases of the base model (Table 1):

Table 1. Relation of base model and BPM structure Source: Own elaboration

Model relationship and BPM life cycle	
Base model	Life cycle BPM
Necessities analysis	Process identification
	Process discovery
	Process analysis
Organization of the Program Plan	Process redesign
Implementation of the Program	Process implementation
	Process monitoring and control

With the improvement in the needs analysis by using the 3 phases of Design Thinking:

- Empathize
- Define
- Devise

In this way, it is expected to obtain information in much more detail which allows an improvement in the solution proposals for the model, and thus, increase the efficiency of design management by 5%.

Innovation and Advantages. The innovation is found in the new structure under the BPM model, which allows SMEs to have an improvement in their management, since BPM is oriented towards process management. Additionally, it can provide a simulation view prior to deciding on a deployment. Finally, Design Thinking contributes to the gathering of information and the search for opportunities, since it focuses on discovering the hidden details, that is, insights, of the collaborators that are part of the design process.

The main advantage of this contribution is to provide a correct structure of steps, provide a simulation view to have a better implementation decision and find hidden problems within the design management process (Fig. 1).

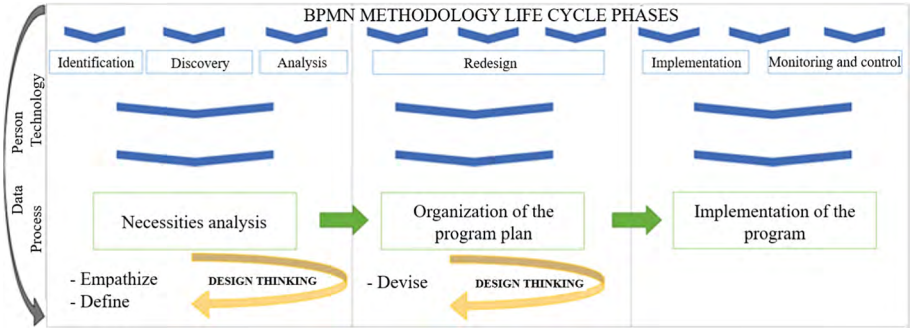


Fig. 1. BPM model under design thinking approach

3.2 Detail

Instrument 1: Identification and Discovery of Needs. In the following instrument, we have the relationship between the first two phases of the BPM cycle for the correct information gathering.

Instrument 2: Needs Analysis. In this second instrument, we have the relationship between the BPM **cycle** phase: Analysis, and the first two adapted phases of Design Thinking: Empathize and Define, together with the Who, What for and Why? by Design Thinking.

Instrument 3: Redesign. In the last instrument, the BPM life cycle phase is related: Redesign and the phase: Devise, of Design Thinking. Which will provide the transformation of the information, since the problems will be taken to insights and these same insights will be triggers for the idea of effective solutions.

3.3 Indicators

The selected indicators will measure the impact of the contribution with respect to the selected base model, taking into account the following:

Employee Satisfaction. The satisfaction of the collaborators within the process, make up an important part of the model, since it is known that not everyone feels comfortable with the implementation of some new form of work. However, with the model, being highly interactive with all design workers, it is expected to have positive results in terms of comfort.

$$Employee\ Statisfaction = \left(\frac{SUM\ \ OF\ \ SURVEY\ \ SCORES}{TOTAL\,SURVEY}\right) \tag{1}$$

Costs. The cost reduction is one of the impacts that it seeks to generate, since today the business environment is much more competitive.

$$COST\ \ REDUCTION = 1 - \left(\frac{COST\ \ OF\ \ NEW\ \ MODEL}{CURRENT\ \ MANAGEMENT\ \ COST}\%\right) \tag{2}$$

Time. The reduction of times is another of the impacts that are sought to generate, since today agile solutions are required that do not stop day-to-day operations and offer quick solutions.

$$TIME\ \ REDUCTION = 1 - \left(\frac{TOTAL\ \ TIME\ \ OF\ \ NEW\ \ MODEL}{TOTAL\ \ CURRENT\ \ MANAGEMENT\ \ TIME}\%\right) \tag{3}$$

4 Validation

4.1 Validation Scenario

It takes place in the IMPREVU company. Company dedicated to the commercialization of men's garments with a European trend, the added value is the innovation in clothing designs every 15 days. The validation of the model was carried out during the month of November 2020, and was carried out virtually, due to the security measures implemented by the government of Peru against the COVID 19 pandemic; and the validation will be given in comparison with the base model mentioned in the contribution section and the current situation of the company.

4.2 Initial Diagnostic

The initial indicators with which the IMPREVU company is currently operating are detailed below (Tables 2 and 3).

Table 2. Initial time diagnosis

IMPREVU design management phases	Average design time
Ideation	3
Sample	6
Test	2
Total	11 days

Table 3. Initial cost diagnosis

IMPREVU design management phases	Average design cost
Ideation	S/264
Sample	S/350
Test	S/128
Total	S/742

This initial diagnosis represents the current way of managing the design by the company.

4.3 Validation Design

To start the case study, the steps of the contribution view were executed. First, a management meeting was held where the proposal was shared with the owners of the company and once the idea was accepted, the information was identified, in which all the information on the components and components could be collected. quantitative data from current design management; It was determined if the information is adequate and then proceed with the "Needs Analysis" instrument, in which we use the DT tool and the "What? Who? and Why?", this is where empathy allows them to feel part of the process and solution. After that, the problems are converted into insights, and it allows us to see the problem from the main root, which allows us to create an optimal solution to each problem found.

Once the insights have been developed, the ideation phase is executed, adaptation of phase three of Design Thinking, through the "Redesign" instrument, which consists of a "Brainstorming" of ideas aimed at generating solutions for each insight. Finally, the solutions devised were implemented, monitored and controlled; two weeks later, the indicators shown in the contribution section were applied, resulting in the following (Table 4):

Efficient designs were obtained in an average of 10 days for the clothing lines, due to the fact that a test was added prior to the development of the sample, where most of the reprocesses were carried out due to lack of prior consensus; this was given by the insights generated in the matrix "Needs analysis" (Table 5).

Table 4. Time improvement results

IMPREVU design management phases	Average design time
Ideation	4
Sample	5
Test	1
Total	10 days

Table 5. Cost improvement results

IMPREVU design management phases	Average design cost
Ideation	S/264
Sample	S/300
Test	S/128
Total	S/692

As a consequence of the lower reprocesses in the samples, the costs were reduced by S/50 compared to the initial one, since the sample ended up being compliant after the initial testing validation (Table 6).

Table 6. Employee satisfaction

Item	Numbers
Total points	55 pts
# of surveys	8 surveys
Average	6.9 pts

In general, the collaborators felt part of the company, empathy was an important factor to enhance their participation. The results obtained were encouraging for the design management, compared to the initial diagnosis. Table 7 shows the indicators obtained:

In comparison, we can say that there was a 9% improvement in the cost of design management and a 7% improvement in operating times, which means that we are in a higher percentage than expected. Regarding satisfaction, the result is on the way to the expected one, this is presumed because it is the first participation of the personnel in the decisions of the company.

Table 7. Validation indicators

Indicator	Result
Cost	9%
Time	7%
Collaborator Satisfaction	6.9 pts prom.

5 Conclusions

The research obtained through an adjustment to the base model applied with BPM and DT, the possibility of improving management performance. It concludes:

- The proposed model reduced costs by 9%, due to the brainstorming by the team based on the insights found, allowed to obtain efficient and agile solutions for the management process on a daily basis.
- Employees obtained an average 6.9 satisfaction when participating in the meetings to develop the model, this because it was their first experience of collaboration in decisions for continuous improvement at work.
- The validation scenarios were carried out according to the management of each line independently, which allowed to verify that the model is applicable for any area.

It is suggested to start research on the use of BPM solutions to business problems, since it allows creating new business opportunities.

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Speaker Identification Method Using Bone Conduction and Throat Microphones

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Abstract. In recent years, the number of workers in Japan's construction industry has been decreasing, and the working environment at construction sites and other facilities is being improved. For example, the use of professional headsets equipped with bone conduction microphones, which enable clear voice communication even under noise, is expanding. Therefore, we aim to improve the performance of speaker identification using bone conduction microphones. In this study, we propose a speaker identification method using the difference of spectrum between bone conduction and throat speech. In the proposed method, Mel log power spectrum of bone conduction and throat speech is calculated. Then, the difference of spectrums is calculated and SVM is used to identify the speaker. The proposed method using the difference of spectrum between bone conduction and throat speech achieves the highest identification rate, which confirms the effectiveness of the difference of spectrum between bone conduction and throat speech.

Keywords: Speaker identification · Bone conduction speech · Throat speech

1 Introduction

In recent years, the number of workers in the construction industry in Japan has been declining and is expected to continue to decline [1, 2]. Therefore, improvements in the work environment are being made to cope with the labor shortage. For example, the use of professional headsets with bone conduction microphones that enable clear voice communication even in noisy environments is spreading. In addition, the use of speaker identification has been studied to confirm the possession of a license at workplaces and to determine a person's identity to prevent information leakage.

In this study, we aim to improve the performance of speaker identification using bone conduction microphones. In this paper, we call speech obtained by condenser microphones, bone conduction microphones and throat microphones as air conduction speech (AC), bone conduction speech (BC), and throat speech (TH). In previous studies, Makimoto et al. [3] and Makinae et al. [4] have used bone conduction speech for speaker identification. The combination of air and bone conduction speech can also improve the

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 729–735, 2022.
https://doi.org/10.1007/978-3-030-85540-6_92

accuracy of speaker identification (Mori et al. [5], Tsuge et al. [6]). Furthermore, the combination of air conduction and throat speech can also improve the speaker identification accuracy (Mubeen et al. [7]). Speaker identification has also been studied using NAM microphones, which are resistant to background noise (Nakajima et al. [8], Okamoto et al. [9]). Speaker identification accuracy has been improved by combining speech. When air conduction speech is used for speaker identification in noise, the identification accuracy is reduced. We focused our attention regarding these two things. Therefore, we propose a method for speaker identification using difference of spectrum between bone conduction and throat speech, and evaluate it through identification experiments.

2 Proposed Method

The flow of the proposed method for speaker identification is shown in Fig. 1. Mel log power spectrum (logMel) of bone conduction and throat speech is calculated and average of all frames of the input speech is obtained. Then, the difference of logMel between bone conduction and throat speech is calculated and the SVM, which has been trained in advance with the difference value of a specific speaker, is used to identify whether the speaker is the corresponding one or not.

In the difference of spectrum between bone conduction and throat speech, the common speech spectrum contained in each speech is removed. The remaining spectrum may contain transfer characteristics due to the shape and tissue of the head and neck. We consider that the transfer characteristics may contain the unique characteristics of the speaker.

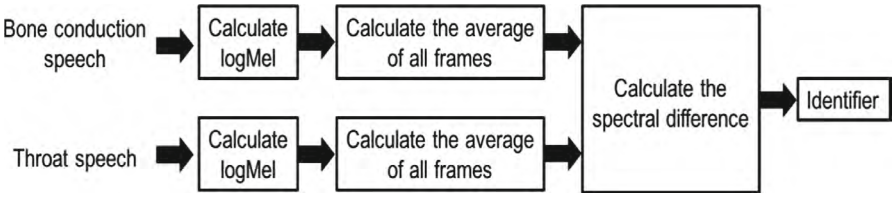


Fig. 1. Flow of the proposed method.

3 Experimental Methods

3.1 Overview of Identification Experiment

Acoustic features are calculated from speech waves using openSMILE. The obtained acoustic features are used to calculate the difference of spectrum between bone conduction and throat speech, and SVM is trained to identify the speaker. Based on the results of this identification, the effectiveness of the difference of spectrum between bone conduction and throat speech is determined. In addition, three types of identification using each speech (AC, BC, and TH) alone are also evaluated for comparison.

3.2 Speech Data

In this study, the following three microphones are used for simultaneous recording in order to use three types of speech: air conduction speech (AC), bone conduction speech (BC), and throat speech (TH).

- Condenser microphone (SONY ECM-530, unidirectional)
- Bone conduction microphone (Temco Japan's EM21N-Tip)
- Throat microphone (Retivis 1 Pin 3.5 mm Throat MIC Earpiece Covert Air Tube Earpiece for Phones)

The speech recording is done in a soundproof room with six 21-year-old adult males. The recorded speech data consists of 20 sentences with 503 ATR phoneme balances. The speech was recorded digitally with a sampling frequency of 48 kHz and a quantization bit rate of 16 bits. In order to analyze the speech with openSMILE, it is downsampled to a sampling frequency of 16 kHz using ffmpeg.

3.3 Experimental Conditions

0–7 dimensional logMel of the average of all frames of the input speech is extracted by openSMILE. The sampling frequency of the extracted speech is 16 kHz, the analysis frame length is 25 ms, and the shift width is 10 ms.

The difference values calculated from the obtained 0–7 dimensional logMel are used as features. In this study, we use this data to identify six speakers (m1–m6) by SVM of Weka [11]. This is a pattern method that separates multiple classes by learning the data. The following equation uses a polynomial kernel function, and SVM setup is shown in Table 1, where $K(x, x)$ i is the kernel function and the others are constants.

$$K(x, x) = (gamma * x * x + coef\,0)^{degree}. \tag{1}$$

Table 1. Setting of SVM

SVMType	Kernel	Cost	Gamma	Coef	Degree
C-SVM	Polynomial	1.0	0.1	0.0	3

We use the confusion matrix to evaluate the experiment. The confusion matrix allows us to obtain Accuracy and F-value. Accuracy is the percentage of correct answers among all the data. F-measure is the harmonic mean of the repeatability and goodness of fit. In addition, since the number of data is very small, we perform a 10-fold cross-validation. For each speaker, there are 18 sentences of training data and 2 sentences of evaluation data.

4 Experimental Results and Considerations

4.1 Identification Results

Figures 2 and 3 show the average values of Accuracy and F-measure for each speech. The identification result based on the difference between BC and TH (98.3%) was higher than the results using AC alone (83.3%), BC alone (95.0%), and TH alone (94.1%). In addition, there was no significant difference in the identification results between the results using BC alone and the results using TH alone. However, the identification results using AC alone were much lower than the other identification results.

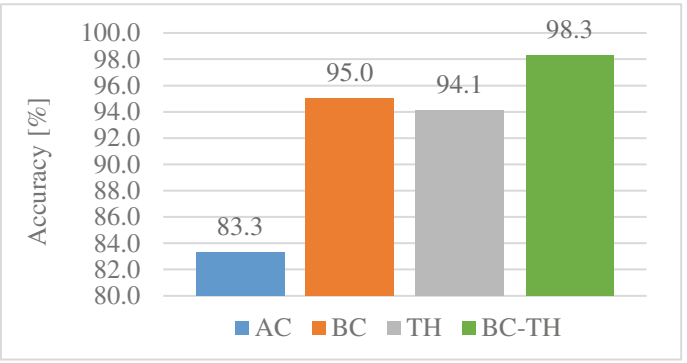


Fig. 2. Average of Accuracy for each speech.

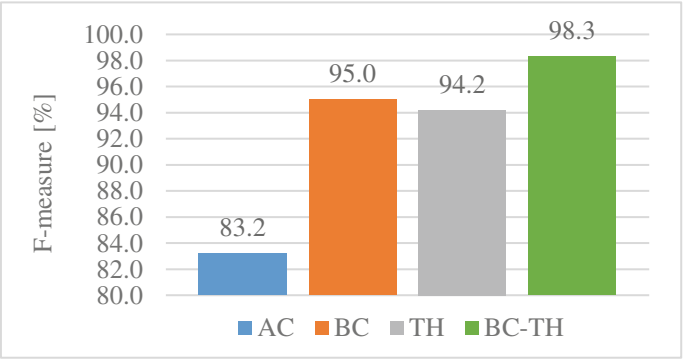


Fig. 3. Average of F-measure for each speech.

4.2 Considerations

The identification result using the difference between BC and TH (98.3%) was higher than that using AC alone (83.3%), BC alone (95.0%), and TH alone (94.1%). Therefore, the effectiveness of the speaker identification method using the difference of spectrum between bone conduction and throat speech was confirmed.

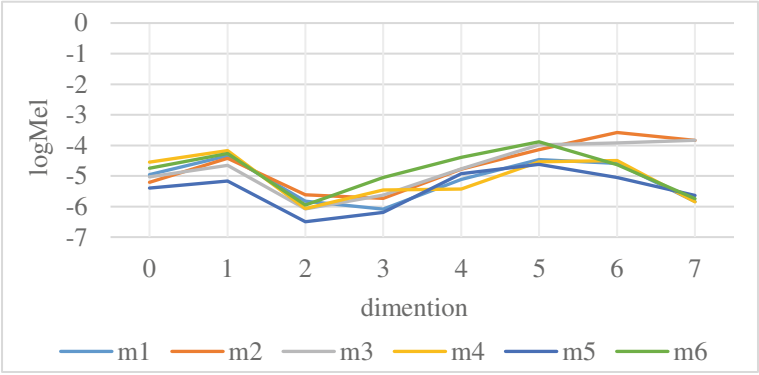


Fig. 4. 0–7 dimensional logMel for each speaker in AC.

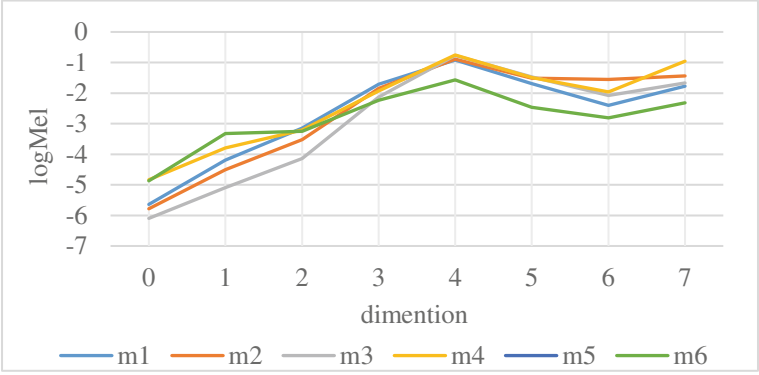


Fig. 5. 0–7 dimensional logMel for each speaker in BC.

Figures 4, 5, and 6 show the average values of feature (0–7 dimensional logMel) obtained from AC, BC, and TH for each speaker. Figure 7 show the difference values of the average of feature (0–7 dimensional logMel) of BC and TH for each speaker. In Fig. 4, we can see that the differences in the values of feature for the speakers are relatively small. On the other hand, Fig. 7 show that the difference in the values of feature for each speaker is relatively large. Also, throughout the identification results, it was easy to misidentify when the difference in the values of feature for each speaker was small,

and it was difficult to misidentify when the difference in the values of the feature for each speaker was large. In addition, BC and TH include transfer characteristics because BC and TH are recorded speech that is transmitted through the human body. On the other hand, AC does not include the transfer characteristics because AC is recorded speech that is transmitted through the air. Therefore, the difference in the values of feature for each speaker in AC is smaller than that in BC and TH, making them less likely to be misidentified, and thus resulting in lower identification results.

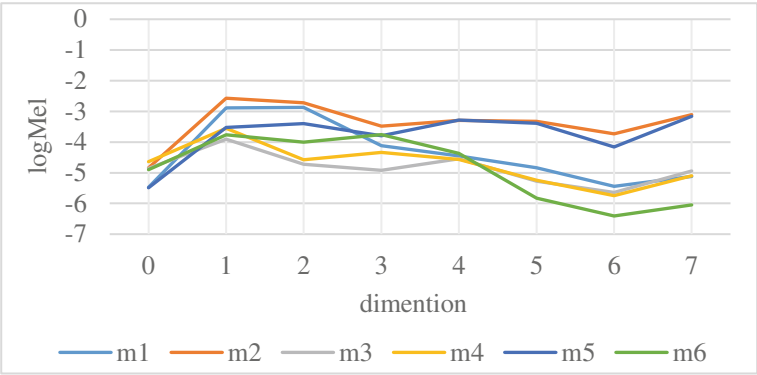


Fig. 6. 0–7 dimensional logMel for each speaker in TH.

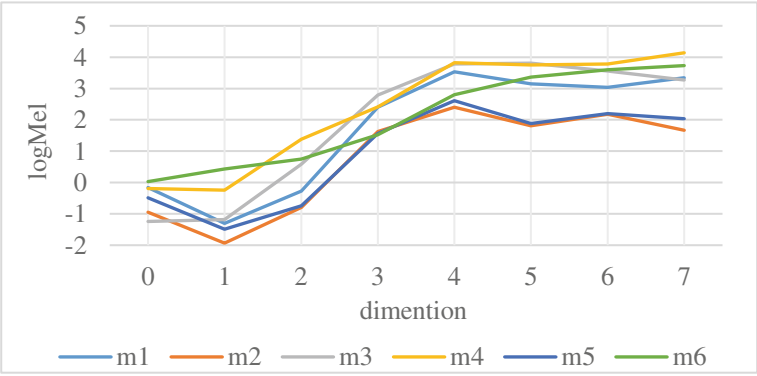


Fig. 7. Difference value of spectrum between BC and TH for each speaker.

5 Conclusion

In this study, we proposed a speaker identification method using the difference of spectrum between bone conduction and throat speech and evaluated it by identification experiments. As a result, we achieved 98.3% of the identification result by the difference of spectrum between bone conduction and throat speech. Therefore, we were able to confirm the effectiveness of the speaker identification method in the difference of spectrum between bone conduction and throat speech. It was also found that the identification accuracy of the speech that contain transfer characteristics due to the shape and tissue of the head and neck (bone conduction and throat speech) is higher than that of the speech that do not contain transfer characteristics (air conduction speech). In the future, it is necessary to examine the change in the identification rate using actual speech in noise. In addition, it is necessary to study the change in the identification rate with the increase in the number of speakers.

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Inventory Optimization Model Applying the FIFO Method and the PHVA Methodology to Improve the Stock Levels of Olive Products in SMEs of the Agro-Industrial Sector in Peru

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Abstract. Food industries face complicated inventory management problems, since the products are perishable, that is, after a certain time the product will no longer be edible. Therefore, the importance of this project is to optimize the inventory control of olive products in SMEs in the agro-industrial sector. Additionally, the goal of the research is to minimize inventory costs and the time it takes for products to reach their respective customers. For this, the indicators of inventory rotation, perfect deliveries, inventory accuracy and satisfied customers were established so that an increase in each of them was achieved and standardization was achieved efficiently. For this reason, the PDCA (plan-do-verify-act) methodology will be implemented, also known as the Deming cycle in the agro-industrial company in order to standardize the processes of reception, location, preparation and dispatch in the product warehouse finished.

Keywords: PHVA · FIFO · Inventory control · Olive trees

1 Introduction

The research focuses on Peru, given that olive production is approximately 133,700 tons, of which 75% is destined for table olives and the remaining 25% is designated for olive oil. At present, there are different varieties of olives, the botija or criolla olives represent 80% of the total, other table varieties such as Ascolana, Manzanilla and Calamata represent 10% of the total, on the other hand, oil olives represent 10%. Peruvians consume approximately 90% of Botija olives, as it is consumed especially for breakfast and for gastronomy [1].

When the olives arrive at the plant, they go to the production area for the different processes depending on the type of product, then they are prepared to be taken to the

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 736–742, 2022.
https://doi.org/10.1007/978-3-030-85540-6_93

packaging area where they are generally stacked and stored at room temperature, which negatively affects quality of the olives and finally they are transported to the warehouse of finished products. Having this last stay inventory control problems. Therefore, the method to be used is the PHVA, as this model allows continuous inventory management and verification.

This study seeks to apply methodologies related to inventory control such as PHVA and tools such as standardized work and FIFO for an olive producing company in order to minimize inventory costs and the time it takes for products to reach the end customer. Procedures were designed for each of the finished products warehouse processes and the use of indicators was incorporated to measure compliance with the methodology and tools, this being the main contribution for the agro-industrial company. The desired results are to improve inventory management as well as reduce inventory recording accuracy, perfect delivery rate, and stock out of stock.

2 Literature Review

2.1 Inventory Management Model in Agroindustries

Coordination in the supply chain operation processes in the agro-industrial sector is essential for optimal decision-making, given that consumer demand is uncertain as the products are mostly affected by the freshness and price of sale, causing impacts on the inventory level and on each of the members of the supply chain [2, 3]. With the model it is proposed to find similar approximations to the EOQ of duration and optimal profit of the cycle, in order to have a more precise comparison with respect to perishable and non-perishable products, to obtain an approximation of the profit margin of the non-perishable good to know how It would be the estimate for the perishable product, applying it in a real life case and thus studying the performance of the approximations [4, 5].

2.2 FIFO Method with Inventory Models in Agroindustries

The uncertainty of demand and the increase in daily orders do not require an optimal order cycle because, having an optimal period between two sequential orders could be longer than the useful life of the perishable product, this is how authors such as Larissa Janssen and Jurgen Sauer agree on the importance of the model for reducing the amounts of waste and for making decisions [6]. By following the FIFO-based model, the company allows the inventory that first enters the warehouse to be the first to leave, that is, it first depletes the oldest units, thus allowing the elimination of obsolete products [7, 8]. Through the implementation of the model a 45.73% decrease in the average level of stocks is achieved, thus allowing a more precise planning of the inventory [6].

2.3 PHVA Method with Inventories in Agroindustries

The Deming cycle has four stages, the first is Planning, in this stage the problem is analyzed and the causes are determined, the next stage is Doing, in this phase a plan is

activated, Verification continues, in this part they are analyzed and compare the results of the previous stage, you can use different tools such as Pareto, Ishikawa diagram and others, finally there is the Act phase, where the improvements are standardized, as long as the objectives have been achieved, and if they were not achieved all the steps mentioned [9, 10] are repeated. The authors Realyvásquez, Arredondo, Carrillo and Ravelo were able to evaluate the methodology in a Mexican company, which has facilitated the detection of opportunities for the inventory management process, in addition to reducing the percentage of defective products, which represents a increased utility of the company [9]. On the other hand, the methodology together with standardized work helps to improve and obtain a competitive advantage over other companies [11, 12].

2.4 PHVA Method with the FIFO Method with Inventories in Agro-Industries

The inventories of perishable products in the finished products warehouse can cause unnecessary storage costs if they are not well managed, it is necessary to put products with a close expiration date first, that is, use the FIFO method for good product management, in addition to the use PHVA as an action plan, which allows the reduction of storage and dispatch costs. According to Francis Ocaña, Walter Estela and Elías Gutierrez, when using the mentioned methods there was a reduction in storage and dispatch costs by 14.52% and 7.41% respectively, since the use of PHVA together with FIFO was beneficial for the company, since in addition of cost reductions, policies and flow charts were developed to correct management errors [6, 9, 13].

3 Input

Inventory management in the finished products warehouse is a problem that several companies present, since in many of them product disorder, differences in physical inventory with the system, errors in the location and preparation of orders are observed. For this reason, decision making is based on the indicators of inventory record accuracy (ERI), stock out of stock, perfect deliveries and satisfied customers. For this reason, the proposal seeks to decrease the accuracy of inventory registration, stock breakage and increase perfect deliveries and satisfied customers through the development of activities related to literature.

The proposed model is developed based on the PDCA methodology in the processes of the warehouse for perishable finished products through four stages, which are: strategy planning, carrying out the pilot plan, verification and monitoring of results, and finally the measurement and review of indicators. The model is considered to apply not only to the agro-industrial sector but also to other sectors. The model creates can be seen in Fig. 1.

It will be applied to the pitted botija olives product, whose economic value represents 79.9% of the company's capital. In addition, the project is applied in the finished products warehouse.

Stage 1: Strategy Planning. Identification of the problem: First, a team is formed, which identifies the problem and plans corrective actions with different tools.

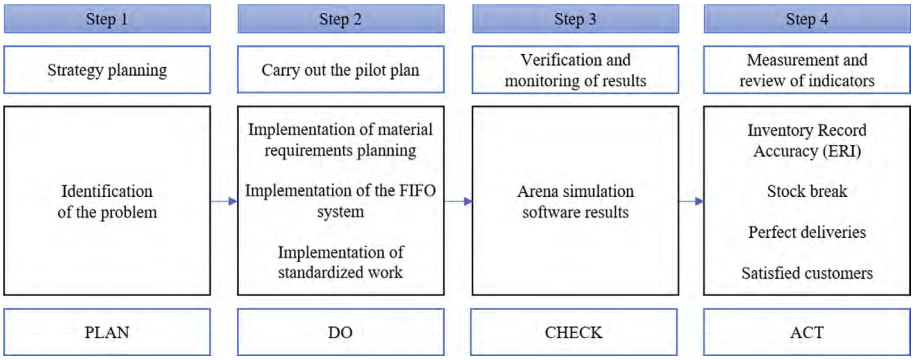


Fig. 1. Model to be used linked to inventory management

Stage 2: Carry Out the Pilot Plan.
Implementation of material requirements planning: At this point, a master production plan (MPS) is made to then carry out the material requirements planning (MRP), since when determining the components that are needed in production, it is satisfied the demand for the final products.

Implementation of standardized work: A standardized work is proposed in the reception, location and dispatch processes in the warehouse.

Implementation of the FIFO system: The method is used in the warehouse, in order to manage the stock, that is, to achieve an excellent inventory rotation, since the products are perishable and have an expiration date.

Stage 3: Verification and Monitoring of Results. The results of the pilot implementation are shown, which are verified with the visualization of the data collection that is observed in the Arena simulation software.

Stage 4: Measurement and Review of Indicators. Finally, for the review of the goals and objectives, the verifications of the indicators of the current situation and the scenario of the proposal are carried out, taking into account Table 1.

Table 1. Indicators reference level

Indicator	Formula	Range
ERI	$\frac{Difference\ value\ (\$)}{Total\ inventory\ value}$	[0%; 5%]
Perfect deliveries	$\frac{Perfect\ delivered\ orders}{Total\ delivered\ orders}$	[98%; 100%]
Stock break	$\frac{Quantity\ not\ supplied\ \times\ Unit\ Cost}{Total\ Quantity\ Requested\ Cost}$	[0%; 6%]

4 Validation

The study will be carried out in the finished products warehouse area, which impacts on the non-fulfillment of orders from a company dedicated to the production, industrialization and marketing of olives. The company produces through an assembly-to-order (ATO) strategy, as this approach seeks benefits such as delivering products to customers quickly. It must be taken into account that the company must satisfy the orders of 157 stores located in Lima. The proposed model consists of four steps, which were explained in the previous section, this model together with other tools help to improve the inventory organization of the finished products warehouse, for this reason the current situation and three different scenarios were analyzed.

4.1 Scenarios and Results

The system begins with the arrival of orders, which occur at certain times and follow a normal distribution. In addition, a replenishment point of 1200 tapers of olives was considered, then the conforming deliveries were counted for the registration of the respective indicator, considering that the warehouse stock can cover the order, also, the orders lost due to out of stock. Orders that could not be completed due to warehouse stock go to production, to then be packaged and sent to the finished products warehouse and perfect deliveries and non-conforming deliveries are counted (Table 2).

Table 2. Indicators of the current situation

	Current situation	Objetive
ERI (%)	7.00%	4.50%
Perfect deliveries (%)	94.12%	97.00%
Stock break (%)	8.27%	5.00%

Scenario 1. The quality inspection process was increased in order to reduce non-conforming deliveries, as well as the location process to properly select the order according to the corresponding customer and the preparation process for the respective dispatch. A minimum stock of 1200 units and a maximum queue were considered to enter the reception area of the warehouse.

Scenario 2. The same processes of alternative 1 were added, but eliminating the maximum queue restriction for entering the reception area. It should be noted that orders that reach production will be given only when there is not enough stock in the warehouse. A minimum stock of 1800 units was considered in this scenario.

Scenario 3. The same processes of alternative 1 and 2 were added. A minimum stock of 2400 units was considered in this alternative.

4.2 Analysis of Results

At the end of the simulation of the three scenarios, a comparison of the scenarios with the current simulation is made, since the purpose of this comparison is to choose the best scenario and compare how much the proposal improved with the current simulation. As shown in Table 3, the third scenario achieved an improvement in all the indicators, however it turned out to be a better alternative than the second option, because it was possible to reduce the ERI to 4%, the stock break to a 3.48%, and increase the indicator of perfect deliveries to 98.96%, this being the best alternative for improvement.

Table 3. Scenario indicators

	Scenario 1	Scenario 2	Scenario 3
ERI (%)	4.00%	4.00%	4.00%
Perfect deliveries (%)	99.00%	98.96%	98.96%
Stock break (%)	17.65%	6.72%	3.48%

5 Conclusion

Our main conclusion is that the main solution is efficient and significantly reduces expired products. For this research, we implemented the first in first out policy in the warehouse area, which is based on the expiration date of perishable products.

The flowcharts and the 5 whys tool allowed to propose improvements in the processes of the finished products warehouse since it allowed a better analysis of the problem, thus, through the incorporation of quality inspection, location and order preparation processes, it was possible to increase the indicator of perfect deliveries to 98.86%

Inventory control is much more efficient with standardization techniques for warehouse processes, since according to the simulation study, stock breakage has been significantly reduced by 4.79% compared to other scenarios.

On the other hand, the gap between the literature and the case study in relation to the inventory accuracy indicator (ERI) was 2%; however, with the implementation of the PHVA model, an accuracy of 96% was achieved, which a in turn, it allowed to reduce planning errors and increase the indicator of satisfied customers by 7.73%; It should be noted that these results were performed using the Arena simulator with a confidence level of 95%.

The proposed solution can be used for other stages of the supply chain, as it allows an inventory organization in the product warehouse and efficiency in reducing expired inventories. In addition, the objective of the model is to satisfy the customer, that is, to increase the level of customer service.

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Augmented, Virtual and Mixed Reality Simulation



Human Factors Evaluation of Shared Real and Virtual Environments

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Abstract. The increased pace of adopting virtual reality (VR) technology in the digital age as a new way of communication, enabled the decision-making concept to evolve in environments influenced by improved technologies and operational processes. Human Factors pertinent to team members sharing a real and a virtual environment (VE) have been examined by capturing the interaction capabilities to gain and maintain individual situation awareness (SA) impacting the team SA level. This baseline has been explored with a Joint Cognitive System foundation and integrated in a modified cyclical model with different modes to measure the level of immersion required for achieving higher levels of SA. In addition, a modified Observe, Orient, Decide and Act (OODA) model is introduced to address how information is collected, processed, and conveyed through the interchange of individual and shared mental models of one user immersed in the real world and one user immersed in virtual reality.

Keywords: Virtual reality · Decision-making · Human factors · Situation awareness · Joint cognitive system · Observe-orient-decide-act · Shared mental models

1 Introduction

The concept of information is multifaced and fundamental to communication. In the present days of digital and communication network advances, loss of information is subjected to technologically mediated communication [1]. Important aspects as body gestures, emotions and face interactions are simply not represented through conventional communication devices like television, radio and telephone. Therefore, the concept of virtual reality emerged to bridge the communication gap by addressing such limitations.

Positioning VR in a communication tool category allow to trace different information type [2] to various virtual degree of abstraction [3]. Furthermore, VR is progressively more designated as a communication system rather than a technology device [4]. Bringing people together virtually without delimiting any human interaction mechanisms on an online social communication medium continues to appeal to organizations championing digital innovation. Engaging communication in VR is directly inspired by human created experience instead than the human-technology interaction.

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 745–751, 2022.
https://doi.org/10.1007/978-3-030-85540-6_94

A VR experience actively provides the means to acquire understanding. This property increases through the active use of human sensors and motorial skills. The VR capability to create understanding of a situation, whether that is by virtually taking part in a concert, seating in a simulator surrounded by virtual environment or walking through a virtual museum, underpins the synthetic generation of knowing what is happening around you. This very individual characteristic falls under the SA concept, as Stamper declared:

"No matter how materially wealthy one is, without good relationships with others and a lively awareness of the world around us, life would hardly be worth…" [5].

The investigation herein illustrates how a human-centered VR, and humans engage through the decision-making process, shape task workload and cognitive processes during the simulation of a real event. Human-centered VR defines humans being part of or interacting with a VR simulator. When interaction takes place with another human a Horizon of Observation is established [6] to observe visual and aural SA interactions. The Decision Representation Language (DRL) delivers an alternative to present the qualitative aspects of decision making [7].

In a team comprising one member immersed in VR and another in a real environment, attention must mediate the sense of presence in a virtual environment that could lead to a sense of illusion with the loss of presence of the user in the real world posed by physical barriers. This fine balance between both users poses a challenge in the development of a shared awareness state. In this process, the shared representational structure constitutes the ability to organize the cognitive mechanisms involved in labelling decision-making and workload. The exploration begins with the contribution towards a common team goal. This approach allows the VR-member to supply sub goals as and when needed according to task requirements. From a team perspective the team SA has been defined "as the degree to which every team member possesses SA required for his or her responsibilities" [8].

This definition relies on Endsley's Three-Step Model of Perception (acquiring facts and elements in a situation), Comprehension (understanding, interpret, evaluation of facts related to situation knowledge) and Projection (entails envisaging the likely development or projection of a situation without external influences). In this perspective the SA is not viewed as a process but a "state of knowledge" while the processes involved in acquiring the SA are defined as "situation assessment" [8]. This model consistently relies on "mental models" firmly created for specific situations, and their lacking is directly linked to processing errors in the information flow [9]. Although Endsley's omitted "Prediction" [10] to return to the three Levels SA definition, this analysis introduces the "Prediction" level. This level is based on the VR capability to describe, explain and predict events (Fig. 1).

The direction of the team SA in a mixed real-virtual team prompts the double loop of human to human-system thinking towards Socio-Technical Systems (STS) which naturally describes the interaction between teams and technical systems [11].

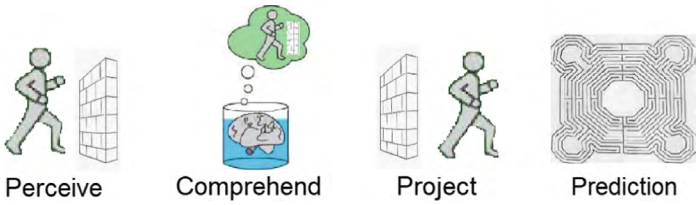


Fig. 1. Virtual situational awareness levels (Public Domain – Labyrinth of the Reims Cathedral on the Left)

2 Team Awareness in a Real and Virtual Environment

The link with the real and virtual environment has transformed the processing of information and communication related to an object (or a place) with perceptual components or processes without representing an occurring awareness state. In addition, to altering or introducing new cognitive properties as a result of the plasticity characteristics of the human mind constantly reshaped under the influence created by virtual environments. VR unconsciously affects human behavior and induces three transitional aspects. The first relates to simulations available and manipulated without spatial perceptual activation resulting in an overlapping of two separated worlds, the second that there is a temporal amodal perceptual state developing without activating sensory-motor actions as a result of a response to a simulated event or situation, and finally it allows to articulate intuitively levels of abstraction needed to trigger levels of awareness without knowledge (declarative or procedural) of the simulated situation. Acquiring information and meaning from data presented visually is a more effective and comfortable way when compared to data presented in a text format. Essentially, this is attributed to the human's cognitive capabilities to observe and interpret visual information [12].

This capability further extended for the VR-member spatial cognition is not upheld by the brain cortex but extends directly out of the brain periphery through Cognitive Integration [13] to the VR representational artifact. In practice, this definition is also aligned to Peirce's outward "aspect of things" [14].

Since information and awareness are two key terms of the problem statement, both terms will be separated from each other. Information sharing relates to organizational, social and technical issues while awareness is needed in a team member to perform a task. The basic structure of a shared SA (SSA) is created by sharing common team SA requirements. The information flow between team members is not symmetrical but adapted to human's interpretation to both virtual tridimensional visualizations and natural observations especially across teams distributed in space and time.

The notion of this theory is reinforced by Hutchins' distributed cognition approach, as "being a kind of cognition, distributed cognition is a manner of thinking about cognition that permits one to examine the relationships between what is in the mind and the world the mind is in" [15]. In this context, as the reference point shift on the user's real environment (Fig. 2), the Joint Cognitive System (JCS) approach is introduced to qualitatively identify the SSA level. Positioning JCS on the VR continuum allows to practically identify the optimum SA position according to functionality and control within an integrated real-virtual system:

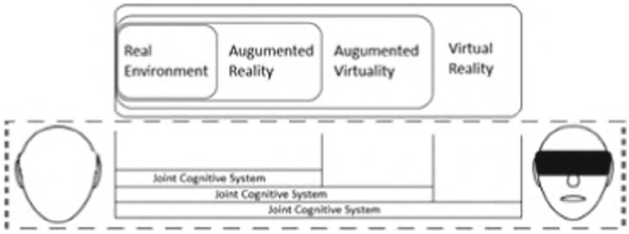


Fig. 2. JCS boundaries (adapted from Hollnagel & Woods 2005) on a VR Continuum (Public Domain)

Once the JCS boundaries have been defined, team SA requirements performance levels need to be fulfilled by individual factors like personal objectives, goals, experience and training, balancing the sense of presence remain paramount to the perceptual level of the SA. In addition, the Extended Control Model (ECOM) [11] is adapted to assess system performance with different levels of control.

The ability to preserve team performance entails developing and maintaining a shared understanding with a shared cognitive interpretation of task requirements and identify elements necessary to maintain shared mental models [16]. As highlighted by Endsley's more data does not equal to more information, the SA construct continues to suffer due to the lack of relevant information needed at the expenses of information overload. The information source provided by VR enable to extract relevant information for each designated task and sufficient level of information for sharing.

The concept of knowledge is abstracted and built according to specific abilities of the knowing and doing in an environmental set, this aspect reflects both psychological and physiological setting to pre-programmed mental model relations. In a shared environment, it is far informal for an artificial simulated stimulation to provide a likely fit for a perceived object as it is for a natural (human) stimulation.

Defining the extents to which VR represent the real world, as well all the variations involved through the physical and psychological fidelity domain are of relevance when performing a task. From a Human Factor perspective, the research embraces all these elements in a metaphorical concept by targeting perceptual and cognitive tasks separately and in combination. In addition, in a fidelity context, avatars could replicate the behavior of the user and assess the Level of SA attained in the simulation.

2.1 Measurement Methodologies

Since the development involves an emerging concept with both virtual and real environmental, a model is proposed that combines the human virtual approach on one side and a human on the other. The OODA model designated initially in the military to deal with uncertainty environment is developed to address SA problems in a mixed environment. Figure 2 begins with a scenario to be designated to clarify or address a problematic situation during a task, once the situation is presented to the team, their reaction is recorded to measure SA levels. The role of the other team member is implicit, based essentially on trust, in this case there is no need for the VR member to go through the loop to act (Fig. 3).

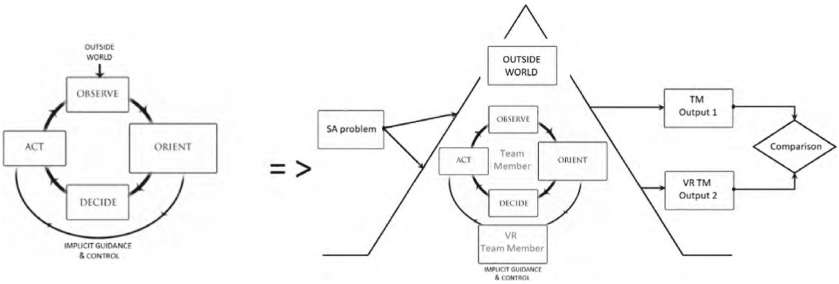


Fig. 3. Positioning Team SA in a mixed real-virtual environment (adapted from the OODA Loop on the left) https://taylorpearson.me/ooda-loop/

Considering the team SA shown in Fig. 2, the next step is to measure and understand the issues affecting teams' performance. Recorded outputs are presented with interaction diagrams to visualize interaction within the team, the assessment continues through evaluating situation indicators, as what does entails being individually aware of a situation? Or of changes in situation? Would be adequate of being individually aware or is there a common awareness emerging through the team interaction? Is a knowledge based or interaction-based construct sufficient to examine the team SA concept?

To represent the validity of the simulated VR experience a general process for evaluating interface and interaction design is established with threshold criteria for optimizing tracking and latency. Nonetheless, evaluation and validation of both individual SA and team SA occurs according to task goals and empirical evidence collected from actual experiments. This relationship is expressed as "But so far as this is anything more than instinctive knowledge, it really rests on experiments" [14].

In addition, VR allows to capture and interpret a complete SA view from Local Awareness to Global Awareness, in continuous time.

3 Discussion

A literature review and empirical review of the shared SA model suggest the highly likelihood of unfulfilled shared SA requirement based on lacking or overlapping individual SA. An example from the aviation domain (Fig. 4) clearly demonstrates the SA as a prominent Human Factor contributor responsible for reducing flight safety margins.

The introduction of VR technology allows through immersion, presence, navigation and interaction to function as an assistive system providing the right time of information at the right time with further support to individual's cognitive processes [17].

In situations employing real-time systems demanding fast decisions, time is critical and VR contribution could prove advantageous for on-time decisions. A closer assessment of Fig. 1, emphasize that the interaction goes beyond the brain-in-a-vat concept since VR becomes part of a body with the brain dynamically interacting in a virtual environment with an active cognitive role [14].

Theoretical knowledge and empirical evidence are needed to assess VR functions and decision making. Evaluation of VR key elements begins from virtual world modeling to immersion, presence and sensory feedback for mapping sensual invariants to

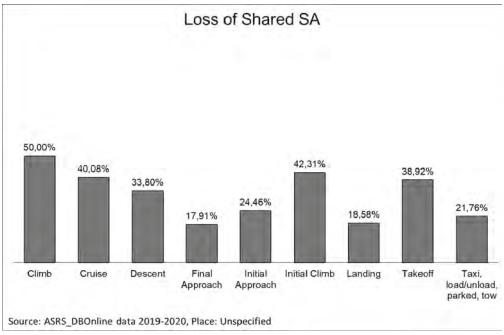


Fig. 4. Statistical exposure of loss of shared SA contribution in aviation – 2019 through 2020 (ASRS Database)

VR proximity. The ability to get into the loop with received information and team interaction are the basis for maintaining a high level of SA. There are six SA measurement categories [18], nonetheless the Grounded Theory method [19] is herein employed to capture emerging SA patterns.

4 Conclusion

The virtual reality term can be split as virtual for what is not real, not factual and reality as what is real! Looking at the definition it is essentially a contradiction, although exactly matching the two main components in the investigation. The SA concept although positioned in the ergonomic domain is still subjected to diversified definitions from researchers and practitioners alike. In addition, the so-called cause and effect paradigm described as situation and awareness can only be a generic approximation as the judgement of each operator (or person) is subjected to various forms of information perceived and contained within mental representations.

The explorative research undertaken has provided the opportunity to compare theories and methods to manage information and to employ a virtual communication tool to fulfil SA requirements. The coordination of perception and actions formed the basis for estimating the levels of SA reached by the team as the application of VR features entails unlocking new boundaries of SA centered on team member interactions.

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TACTILE – A Mixed Reality-Based System for Cognitive and Physical Training

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Abstract. Older adults are often affected by a decline of mental and physical abilities, which results in frailty, anxiety and reclusiveness. They often live alone; family and friends cannot visit them on a regular basis and thus they suffer from social exclusion and loneliness. TACTILE tackles this problem by fostering an active lifestyle and the wellbeing of the elderlies. TACTILE's novelty is the use of Mixed Reality that makes the remote partner virtually present. Continuous user feedback collected in three workshops guarantees that the user interaction and experience will meet the end users' needs. In this paper we describe the TACTILE system and its components, the strong end-user involvement, and the results from the second user workshop, where the second prototype was tested. The system will be validated in final field trials in two test countries – Austria and the Netherlands – with the elderly people and secondary end-users (family members and caregivers).

Keywords: Mixed Reality · Cognitive & physical training · Social inclusion · Tangible interaction · User experience

1 Introduction

Increasing levels of physical activity is an essential factor to improve health [1, 2]. In case of the elderly, regular physical activity helps to reduce the risk of falls and increases health benefits [1, 2]. Besides, social interaction and emotional wellbeing are known factors for supporting their health and improving quality of life [3, 4]. While scientific evidence shows a relationship between cardiovascular fitness and good health, health professionals face the challenge to motivate older adults to increase their physical activity and to meet the recommended levels of activity [5]. Previous research has shown that the risk of mental and physical decline can be reduced by playing challenging games, interacting with other people, and doing physical exercises [6–9]. Moreover, playing games helps especially older adults because they can exercise their skills while being engaged with family or friends. The combination of physical and cognitive activity induces cognitive gains [8, 10]. Augmented Reality (AR), Virtual Reality (VR) and Mixed Reality

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 752–759, 2022.
https://doi.org/10.1007/978-3-030-85540-6_95

(MR) technologies offer new opportunities to support this group because they offer novel ways of interaction that enable users to perform physical and cognitive exercises in a fun and interactive way. Especially MR offers new possibilities for interacting with the environment and other users. The literature highlights some AR and VR applications for older adults [11–13]. However, existing solutions focus on rehabilitation and entertainment, but do not offer communication or the possibility to do cognitive exercises like playing a board game together with a real person, especially combined with physical trainings.

The project TACTILE aims to foster an active lifestyle and the wellbeing of elderly individuals. Within the project, a MR solution is developed that connects seniors with their family and friends and supports their social interaction. The application focuses on the communication and possibility to interact with a real person and stay mentally and physically fit. The first developed prototype focused on user interface and interaction design and included two physical exercises. Initial results showed the usability, accessibility, and acceptance of users [14]. In this paper, the current TACTILE system and its components are described. Further, the paper presents the results of the second user workshop and outlines recommendations for the final workshop.



Fig. 1. End-users testing the TACTILE system: users doing physical exercises (left and right image), user plays Ludo with a remote opponent (middle image)

2 Technical Overview

The TACTILE system consists of two parts: A MR application that offers well-known board games and physical exercises, and a web-portal that allows secondary users such as caregivers or physiotherapists to manage user accounts and configure a recommended training program. The MR app is running on the Magic Leap One[1] (ML1) glasses. The current prototype of the system offers two board games – Halma and Ludo – as well as 14 different physical exercises.

2.1 Board Games

The TACTILE system is designed to combine well known experiences with innovative aspects. Older adults can play well known board games with remote partners. Contrary

[1] https://www.magicleap.com/en-us/magic-leap-1.

to other online-based solutions, in TACTILE users play the game on a physical game board and with physical game pieces. The game pieces of the opponent are projected onto the physical game board within the MR headset (see Fig. 2). This allows the players to experience the tactile feedback of playing a board game although being physically separated from their opponent. Computer vision algorithms detect the location of the game board as well as the player's game pieces. The game board is detected using AprilTag[2] visual markers mounted onto the game board. From the calculated location and rotation of the markers, the position and rotation of the game board in real world coordinates are derived. Using the well-known geometry of the respective game board, every possible position of a game piece can be calculated in the camera image of the ML1. Pink checker figures are used as game pieces and can be robustly detected. The use of flat game pieces prevents occlusions of other field positions from low viewing angles. To allow for different and especially changing lighting conditions continuous white balancing is done using the white areas of the markers. To increase the social aspect of gaming, a VoIP connection is established during the game. The modular game configuration system of TACTILE allows for easy changes to existing game boards (e.g. board redesigns) and integration of other classic board games such as Nine Man Morris or Checkers.



Fig. 2. Left: physical game board with virtual game pieces projected onto the game board. The blue game pieces are the own ones and the green game pieces the opponent's one. Right: User with game board and physical game pieces.

2.2 Individual Trainings

In order to help the elderly in staying physically fit, the TACTILE app offers users the possibility to perform physical exercises with a virtual avatar (see Fig. 3). Users of the TACTILE app – referred to as primary users – can place the virtual avatar inside their real-world surroundings, e.g., in the middle of the living room. Once this step is done, the avatar explains and demonstrates physical exercises which have been recommended to the specific user. Moreover, the avatar encourages and accompanies the user in a joint training session. The three-dimensional representation of the avatar in the real world helps users to easily follow along with the exercises, as it closely resembles a real-life training scenario with a personal coach. This is especially beneficial for older adults

[2] https://april.eecs.umich.edu/software/apriltag.

without prior technical or training knowledge. Physiotherapists or skilled care residential caretakers – referred to as secondary users – can use a web interface to adjust training plans and difficulty levels for primary users. Adapting the training to the individual needs allows for addressing potential physical limitations of users and avoids frustration with generalized training plans for older adults.



Fig. 3. The virtual avatar, displayed in the MR glasses, demonstrates the physical exercises.

3 Design and Development Methodology

TACTILE utilizes a user-centered design approach. In the beginning of the project, user requirements were collected by both involved end-user organizations GedächtnistrainingsAkademie (GTA) in Austria and TanteLouise (TAL) in the Netherlands. During the development phase, and especially during the three planned end-user involvement workshops primary and secondary users are constantly providing valuable feedback. The results of the first user workshop, focused on the user interface and interaction design, the avatar design and the first two training exercises. The outcomes of the first user workshop have been published in [14]. The second user workshop started in March 2020. In this workshop users evaluated the second TACTILE prototype that provided the board game Ludo and 6 exercises (see Fig. 1). The results of this workshop are described in Sect. 4. The third prototype of the MR app, described in Sect. 2, is currently tested in the third user workshop. The feedback of this user workshop will further improve the final prototype that will be used during the field trials, starting from May 2021 in Austria and the Netherlands. The following section describes how user needs have been included into the development process.

3.1 Board Games

To design and implement the board games familiar to all involved users – as mentioned above – requirements were collected to identify common games in both test countries. Based on the outcome and the technical feasibility, the board games Ludo and Halma were implemented. Since it is common that older adults often have problems with their fine motor skills, the consortium decided to use bigger game figures and a bigger dice for

the board game. Since an easily understandable user interface is of utmost importance, especially for the elderly population, a special focus has been placed on the development of an easy-to-understand UI logic that connects two players with each other. When the user chooses to play a board game, all other currently available users are shown with their image inside the MR glasses. As soon as the user selects an opponent, the remote player gets an invitation. Once this invitation is accepted, they can choose together which game they want to play since they are connected over VoIP. The board game Ludo as well as the logic to connect to another player have been evaluated during the second user workshop. With these findings, described in Sect. 4, we enhanced the game by adding visual and audio hints when someone was kicked out or an opponent moved a game piece. Further, the algorithms for detecting the game figures were enhanced based on the problems that have been identified during the user workshops such as displaying hints for situations when the game board or game figures are located outside the ML's field of view (FOV).

3.2 Physical Exercises

To help users with physical training, a virtual avatar is used. Exercises are both explained verbally and demonstrated visually by the avatar, so older adults can easily follow along. Based on the collected end-user requirements, 14 exercises are designed and developed within the TACTILE project. The available exercises are tailored to fit the special needs and requirements of the primary target group. The training process supports users and constantly reminds them to comply with safety recommendations such as holding onto a chair while exercising or special tips for people with an artificial hip joint. Exercises are performed with the support of a virtual avatar, which is projected into the user's homes. This setting offers that exercises can be performed at any time in an environment the user is already comfortable with. Compared to VR, TACTILE's MR solution supports safety aspects since it is less likely to accidentally bump into walls during exercises, or lose balance, as the real-world environment is always visible. Due to different abilities of older users, no single training plan would fit all users equally or properly. To match individual needs, TACTILE implements a feedback loop so that proper training plans can be created. After each exercise, the user is asked about how comfortable he or she felt with the current difficulty level of the performed exercise. This feedback is then used by physiotherapists and caretakers to adjust not only the difficulty levels of individual exercises, but also the list of suitable exercises for the specific user. The web interface that offers this functionality can be used to personalize the training plans of several users, while the same MR application is used for every user. Since people of TACTILE's target group do not usually have special training equipment at home, none of the exercises require any. However, household items like chairs and tables are included into the training plan and used instead. The avatar reminds users whenever such an item is needed for the upcoming exercise. Using furniture can help the elderly to safely perform exercises, for example by holding onto the backrest of a chair to keep balance.

4 Results

The second workshop series in Austria and the Netherlands started in March 2020. The following section describes the user workshop methodology and the elaborated results from the workshops held in Austria. N = 17 primary users (PUs) (11 female, 6 male) and N = 19 secondary users (SUs) 12 female, 7 male) participated in the workshops. The sociodemographic data shows that the PUs in Austria were on average 76.6 years old (±6.13 SD) and the SUs were 42.6 years old (±14.06 SD).

4.1 Test Sequence During the Workshop

The second user workshop was split into two parts. First the participants had to switch on the glasses, launch the TACTILE app, connect to a remote opponent and play the board game Ludo together. After finishing this task series, they were asked to perform a physical training accompanied by the TACTILE's virtual avatar. Users had to position the avatar within the real environment, choose a male or female avatar, perform a whole set of exercises, choose a single exercise from a list, and finally give feedback about the exercises. During these tasks, the participants have been observed and an observational log has been created by the workshop leaders. After each of the main tasks, participants assessed the Augmented Reality Immersion (ARI) questionnaire [15] and the User Experience Questionnaire – Short (UEQ-S) questionnaire [16].

4.2 Observation Results

Playing the game Ludo for the first time via the ML1, 52,94% of the PUs and 21,05% of the SUs tried to grab the virtual game pieces instead of the real ones. Similar behavior was observed in situations where users had to remove a game piece because of being tossed out by an opponent. 5 out of 17 (29,41%) PUs asked how they shall proceed and how the game piece will be removed from the board. This problem did not occur for SUs. The biggest change request – stated by 91,6% of the participants – was to implement a possibility to see the opponent's dice in order to be sure that the remote player is not cheating. During the board game, detection problems were observed. When a user moved the game piece, it took the virtual game piece long to follow and fit the position of the real one. Sometimes the virtual game pieces did not fit the real ones at all. This problem occurred in cases where participants did not look straight at the game board. Thus, not all game pieces were in the FOV of the ML1 and thus, the object detection algorithms could not detect all game pieces accurately.

For the avatar session, 70,59% of PUs had problems placing the avatar in the room so that the avatar has enough space to show the exercises. During the training, 58,82% of the PUs and 42,1% of the SUs could not distinguish between the initial exercise instructions and the actual training part. Further, the participants requested the possibility to skip instructions and to start the training immediately as well as the possibility to adjust exercises and difficulty levels.

4.3 UEQ-S

The UEQ-S questionnaire has 8 items that aim at two different scales, the systems pragmatic quality (e.g. usability) and a hedonic quality (e.g. fun and novelty). The results showed that both PUs and SUs rated the game and the avatar in a very positive way compared to the benchmark (see Fig. 4). SUs were more critical about the system than PUs. PUs rated the pragmatic quality of the board game with a mean value of 1.7, which correspondents to a good result compared to the benchmark. In hedonic quality PUs rating was even higher (mean = 2.39). SUs rated the pragmatic quality for the boardgame with 1.32 and the hedonic quality with a mean of 2.0. Similar results have been provided for the avatar session. PUs rated the pragmatic quality with a mean of 1.8 and hedonic quality with a mean of 2.16. SUs rated the pragmatic quality with a mean of 1.49 in the average field and the hedonic quality with a mean of 1.94 in the higher range. The results of the ARI questionnaire represent our baseline which will be compared to the outcomes of the 3rd workshop and the field trails.

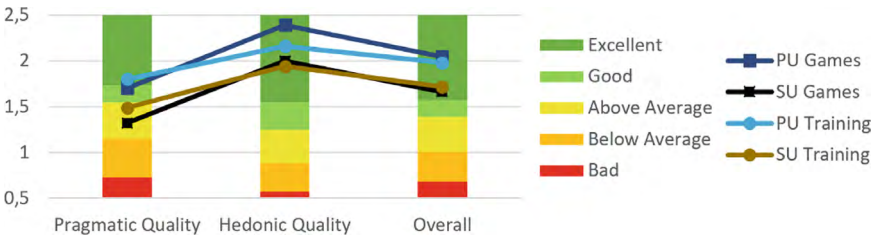


Fig. 4. Results of the UEQ-S questionnaire

5 Summary and Outlook

This work highlights the goals, technical prototype and the results of the second user workshop of the TACTILE project. The paper outlines the benefits of the MR-based solution. As outlined in Sect. 4, the end-users enjoy the solution which is reflected in the positive evaluation results. The major wishes towards the final prototype are, seeing the opponent's dice, an easier avatar placement and the possibility to skip the exercise introduction. The feedback of the second workshop was incorporated into the third prototype that is currently tested in the third end-user workshops. The outcomes of this workshop will be incorporated into our future activities A final prototype will be tested in long-lasting field trials – starting in May 2021 – with primary and secondary end-users in Austria and the Netherlands.

Acknowledgments. The project TACTILE is co-funded by the AAL Joint Programme (AAL-2018-5-143CP) and the following National Authorities and R&D programs in Austria, Switzerland, and the Netherlands: FFG, Schweizer Eidgenossenschaft, ZonMw.

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Autonomous Language Learning with Augmented Reality – An Individual Case Study

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Abstract. We want to motivate and inspire children to learn languages with the help of augmented reality. In this individual case study, we evaluate the potential of our Augmented Reality learning assistant "ARTranslate". We conduct a individual case study by letting children do everyday shopping with the help of our augmented reality learning app. We evaluate these repeatedly with queries in the following days. The respective retention rates range from 26% to 92%. We were able to show that children autonomously learn foreign language terms with the help of our augmented reality learning initiator. To start the initial motivation when learning a new language, ARTranslate has delivered strong indications of high effectiveness.

Keywords: Human computer interface · AR · Augmented reality · Autonomous learning · Language learning · Deep Learning · Object recognition · SceneKit

1 Introduction

The European Union has postulated multilingualism for all people as an educational goal since 1995 [1]. In order to achieve this, an early language acquisition is to be worked towards, in particular in the child development as a starting point for the future of the society. The aim is for everyone to speak "at least two community languages in addition to the mother tongue" [1, p. 59]. Multilingualism is an essential basis for the increasing internationalization and diversification of the society [1, p. 6]. In order to intensify this, the Commission of the European Communities developed a new framework strategy for multilingualism in 2005, in which the teaching and learning of foreign languages in "Youth, Civil Society and Culture" is to be supported as one of the further measures. [2, p. 8].

In a student survey from 2020, 83% of students see digitization as an opportunity for schools. Only 13% of respondents said they see digitization as a risk [3]. Accordingly, there is a positive view of the use of digital devices. Almost all children and young people in Germany own a smartphone nowadays [4]: 75% of 10–11 year olds and 95% of 12–13 year olds. [5]. In the JIM study conducted in 2020, 1200 young people aged 12–19 were surveyed. Of them, 99% had a smartphone [6, p. 6]. So let's use this ever-present device as a starting point for language learning.

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 760–767, 2022.
https://doi.org/10.1007/978-3-030-85540-6_96

2 Related Work/Background

Rheinberg and Engeser describe "intrinsic motivation" as "need for self-determination and competence", "interest and involvement" and "congruence of means and purpose". [7, p. 427ff]. The use of a mobile application in the everyday living environment by children and young people utilizes the principles of intrinsic motivation. Children can learn "for their own sake, independent of factors outside the person". [8].

At German schools, children and young people usually learn two foreign languages. "Foreign language teaching is (…) generally oriented towards single languages, foreign language teachers see themselves primarily as representatives of their language field". [9, p. 35]. As a result, little networking between languages is possible. Furthermore, language learning is usually limited to the school context. This makes it difficult to transfer language learning to the living environment of children and young people. Therefore, children and adolescents should "acquire languages by themselves" [9, p. 35], even beyond the foreign language lessons at school. This is referred to as "natural foreign language acquisition" outside the classroom [10, p. 122]. The use of the smartphone makes *autonomous learning* in different contexts possible.

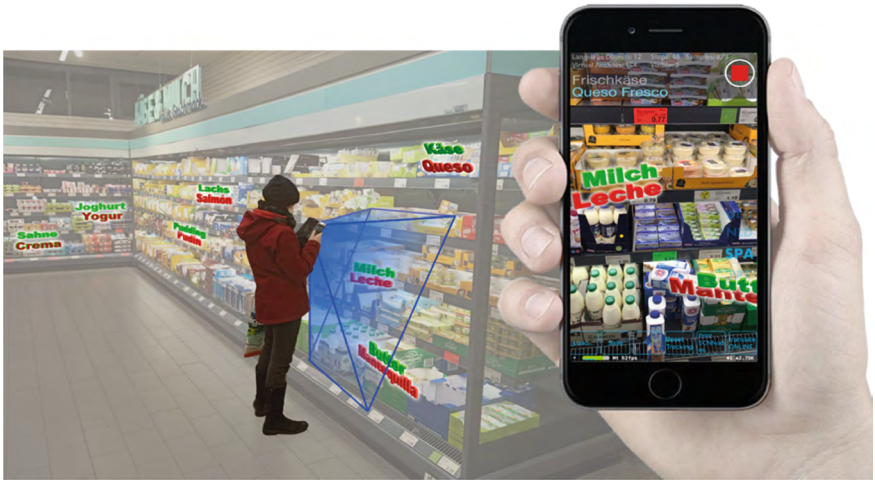


Fig. 1. Study participant doing independent shopping. Shown are the virtual language objects, here as an example in L1 language German (green) and Spanish (red). These "stick" to the groceries during the entire shopping process and float as text objects in the real environment. On the right side the corresponding screenshot of the device.

3 Methods

3.1 Used Groundwork

As a starting point we used our self-developed mobile application "ARTranslate" [11]. Users can use it to explore their environment interactively and autonomously in different languages. The software recognizes up to 1000 objects in the user's environment by using a Convolutional Neural Network (CNN) based on Deep Learning methods and names them multilingually. Augmented Reality (AR) is used to overlay real world objects with virtual 3D learning objects in selectable languages. The "sticking" of the virtual learning objects to the real objects is realized by *markerless AR* [12]. By switching between several languages, the user is able to interactively discover the everyday objects around him in many languages, shown in Fig. 1.

3.2 Further Development of the Open Source Application "ARTranslate"

ARTranslate is a software implementation for Apple iOS devices. The software is available as open source.[1] In order to further develop the augmented reality application into a research-ready tool, we have implemented analysis features and extensive logging. The tracking of real-world objects within a room has been extended so that the application is now able to detect objects in rooms larger than 40 m^2 and to find their virtual anchors in the real world. Furthermore, it is now possible to save complete shopping sessions and load them back into the application at a later point in time when the user returns to the store. The virtual learning objects in the real-life environment can now be classified according to visibility, duration and viewer distance by using a backtracing method of the learning objects to 2D screen projection. The retention rate can be evaluated depending on this. A functional overview shows Fig. 2.

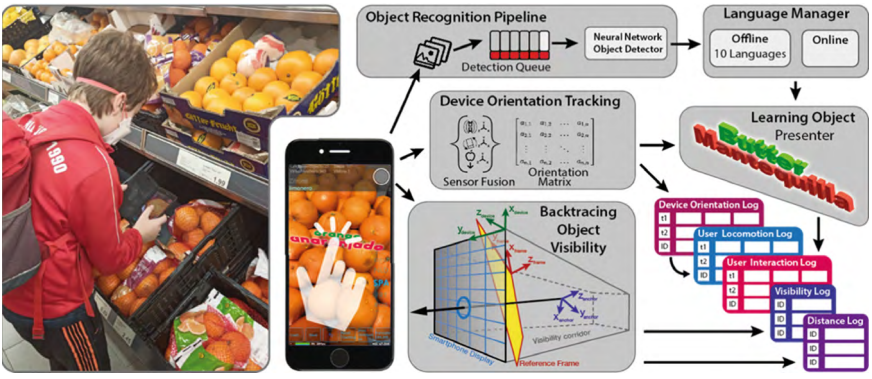


Fig. 2. Software enhancement overview/ study participant during one of the interventions and a screenshot of what the situation is like for the person being studied.

[1] Open Source Application: https://github.com/benpla/ARTranslate.

3.3 Study Design

The present study is a field study [13, p. 206] in the daily life of children and adolescents. The study is based on Tomasello's "usage-based concept" of child language learning [14, 15], The study is based on Tomasello's "usage-based concept" of child language learning, according to that languages are learned "through their current use" [16]. In accordance with this, the vocabulary is determined not by theoretical fiat but "by observation of actual language use in actual communicative events" [15, p. 61]. The language acquisition is based on concrete psycholinguistic units and on "concrete linguistic patterns used in certain contexts" [10, p. 150]. This approach makes the life environment related AR-based method particularly suitable for initial stimuli in a foreign language. Because of pandemic limitations, we conducted the study as a quantitative single participant design" [13]. This means that "the person under examination is at the same time his own control person" [13, p. 765].

For each child or adolescent, we investigated two different languages (Table 1). We used an ABABAB plan for one language and an AB design for the other. Intervention phase a consisted of a complete purchase in each case. The child or young person received a smartphone for this purpose. The smartphone contained the shopping list and our ARTranslate application. The application detects all objects in front of the camera during the entire shopping trip using a machine learning algorithm and shows the object names on the display. The child or young person can tap real objects that interest them and thereby "stick" the translations as augmented reality objects to the groceries. In this way, they open up these terms during the shopping process. The virtual anchors in the real world remain throughout the entire shopping session. In this way, a virtual world of learning objects in the selected foreign language is created in parallel to the physical store environment during the shopping session (Fig. 1).

The control phase B consisted of querying the seen vocabulary or object names in the days after the shopping. After 2 days (intervention 2) or 5 days (intervention 3), the app is used again during the shopping. Subsequently, the terms seen are again queried plus the terms from the previous interventions. Periodically, the terms are queried again to determine how many and which terms were retained.

In addition, we conducted a study with a second language. For comparison purposes, only one intervention was used here.

3.4 Study Conduction

The study participants were an 11-year-old boy and a 14-year-old girl. The focus is on a language that the child or adolescent does not speak, i.e. on which they have as little prior knowledge as possible. However, there is a basic interest in learning this language. In the preceding questioning the examined persons could freely choose the languages they were interested in (Table 1).

Subsequently, we queried the possible vocabulary words in order to exclude or record any previous knowledge. The questioning showed that both persons did not know any words in the chosen main language. In the second language, which was to follow the AB design with a single intervention, the child had no knowledge, while the adolescent knew 3 vocabulary words. These were documented in order to exclude them from consideration

when looking at retention rates. A strong focus on the everyday world constitutes the core of the study. In the process, the subjects have the task of exploring the store all by themselves. After shopping, the logged data is read out. The corresponding words were queried immediately and in the following days.

Table 1. Overview of study participants: choice of languages, chosen study design.

Person	Language		Prior knowledge	Study Design	Interventions	Checks
Adolescent 14 year old girl	1	SPN	No	ABABAB	3	13
	2	ENG	Yes, 3 documented words	AB	1	13
Child 11 year old boy	1	SPN	No	ABABAB	3	12
	2	FRE	No	AB	1	12

4 Results

During the intervention phases, 9937 data points were recorded for the adolescent and 18368 for the child. 2192 (adolescent) and 2023 (child) of these data points carried visibility markers. From these, visibility distances up to 125 cm (Adolescent) and 200 cm (Child) were determined. The median viewing distance was 28 cm and 80 cm.

After the first intervention phase, the immediate retention rate of the main study language SPA was 3 words out of 21 seen for the adolescent (14%), and the child had seen 10 words and could remember one (10% retention rate). In subsequent interventions, the vocabulary words to be remembered increased to 40 for the adolescent and 23 for the child. The adolescent's retention rates decreased slightly at the beginning and increased steadily from the third intervention. The final retention rate was 53%. The child's retention rates remained constant after each intervention after a slight drop at a value of 22%.

The (second) language examined by means of AB design showed a similar course in the child. The retention rate dropped from 36% to 29% shortly after the intervention and remained at this level. For the adolescent, we registered a sharp drop in retention from an initial 50% to 20% after the first intervention. Subsequently, the retention rate increased steadily until the 13th examination day to 90% (Fig. 3).

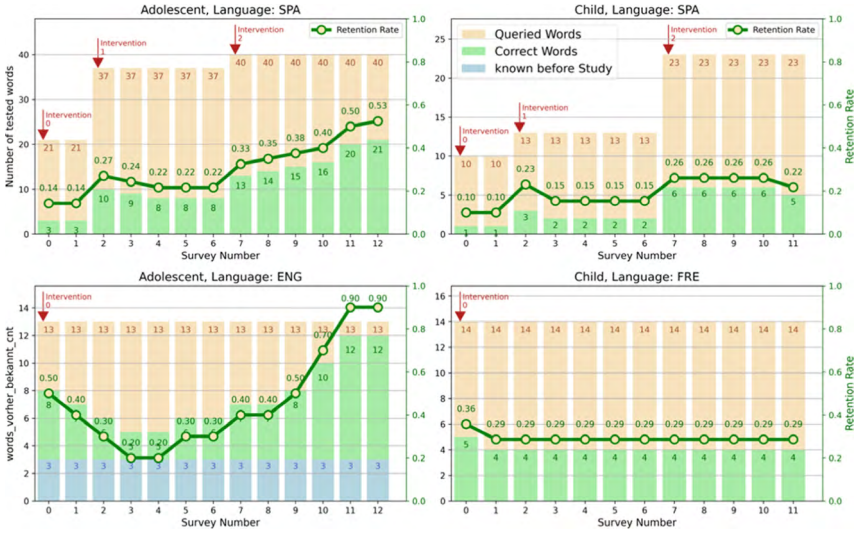


Fig. 3. Interventions and control phases of the studied individuals, each in 2 languages. The ABABAB study with 3 interventions each in the top row. The AB study with the second language selected shows the bottom row.

5 Discussion

With the AR learning app, the terms between different languages can be compared directly. Differences and similarities are easy to identify. In a recent study from 2020, Prokopowicz explicitly demonstrates the usefulness for the languages Spanish, French and German when conducting a series of lessons [9, p. 57]. All investigated languages were non-native languages (Spanish, English, French, environmental German) Nevertheless, we found a high intrinsic motivation. We assume that the intrinsic motivation is even higher when the application is used in a country with the corresponding language as the environment language.

Both participants enjoyed shopping with ARTranslate very much. We could see a great enthusiasm in looking at the virtual learning objects. The child and adolescent were so busy with the playful element of looking from all sides and walking around the sticked objects that they did not even pay direct attention to the vocabulary, but looked at the virtual objects themselves. They did not notice that they were in the middle of a learning phase.

We found that the retention rate in the main language was initially very low at 10%, but increased over the course of the study. This increase was much higher for the adolescent than for the child (by 39% to 53% compared to an increase from 11% to 22%). The adolescent showed a strong increase in interest during the course of the study, whereas the eleven-year-old boy showed less motivation. The motivation of this boy was so low that we consider the vocabulary that was nevertheless memorized to be well established. For example, the astonishment at the Spanish word plátano (Spanish for "banana") was so great on the very first day of intervention that it was reliably repeated over the entire period.

The Single Intervention Study was to be used for comparison with the Triple Intervention Study (ABABAB). Our presumption was that the number of initially memorized vocabulary words would decrease over the course of the study, since no new interventions would take place. The boy's progression only partially confirmed our presumption, as the retention rate only initially decreased, but then remained constant. The course of the adolescent surprised us: after an initial drop that was consistent with our presumption, the retention rate increased continuously from survey 5 and exceeded the initial retention rate from survey 10. The adolescent is already learning two foreign languages and, according to her own statement, has discovered parallels in spelling with the third foreign language to be learned through the app. In our opinion, this interconnectedness was the reason for the increase in the retention rate.

6 Future Work, Conclusion

A follow-up is planned after two further months. This is to determine whether terms have been memorized and internalized in the long term. This single case study represents a first impulse and should be extended to a study with large groups in order to be able to present possible statistical significances. Group studies could also determine whether the child's stage of development in terms of age has an effect on the study results. It would also be possible to look at possible differences between the sexes.

The survey of the studied persons revealed a strong wish that the app should pronounce the vocabulary. Such an extension would significantly increase the connection to real language use.

We were able to show exemplarily that the use of augmented reality and the integration of virtual learning objects in everyday situations triggers a learning impulse in children. We are aware that the learning effect strongly depends on the individual situation. We are also aware that automated object recognition does not enable further learning due to its inherent limitations. In this context, think of situations such as arriving in a foreign country. The application makes it possible to get acquainted with the everyday terms of a foreign language simply by looking through the "intelligent" glass of a display without any additional effort, such as the effort of take input to a translation program. Thus, in a store or on the street, many everyday objects can be learned in a playful way. The app enables individual learning in an individual context.

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Testing UX Performance and Reception by Combining Emulated Android GUI with Virtual Reality Prototyping

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Abstract. This paper explores an application of immersive Virtual Reality (iVR) as a medium to combine Android Graphical User Interface (GUI) development and CAD-based virtual prototypes to improve user experience testing. We also present tentative experimental findings, that a virtualized GUI need not be realistically placed or sized to be evaluated in an iVR environment .

Keywords: iVR · Virtual reality · UI prototyping · Android · Emulation · Unity 3D · Industrial machine · User experience · UX

1 Introduction

Immersive Virtual Reality (iVR) through Head-Mounted Displays (HMD) has seen major developments in recent years. With the successful crowdfunding of the original Oculus Rift in 2012, the subsequent notable releases of the HTC Vive, the Valve Index, up to the most recent second iteration of the stand-alone Oculus Quest. The whole market was estimated to be valued at 15.81 billion USD in 2020 at a projected annual growth rate of 18.0%. With HMD being the dominant technology, making up 60% of iVR revenue [1].

Growing availability and sinking costs make iVR an attractive platform for use-cases besides videogaming. Serious applications include alternative forms of communication, immersive training and virtual prototyping, though benefits are not always self-evident and need to be scrutinized. This paper shall serve as a reference on how virtual prototyping may be implemented in iVR and explores the validity of the approach. It shows how an Android application, serving as a GUI for an industrial dough sheeter, can be displayed in iVR. Technical limitations lead to poor readability of especially small text in iVR, therefore we additionally try to answer the question, whether User Experience (UX) assessment differs from reality when GUI placement and scaling is modified to compensate.

The then prototype of an industrial dough sheeter and a newly designed GUI were evaluated as a real-world use-case for this technology and avenue of research.

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 768–773, 2022.
https://doi.org/10.1007/978-3-030-85540-6_97

2 Technical Implementation

The prototype for the dough sheeter was conceived as a two-part system. One being the physical hardware to process dough, in addition to numerous sensors, the other being a custom Android-based screen that would take sensor data, predefined or custom sheeting routines and immediate user input to optimally process the dough. To realistically create these two parts in iVR, a Computer Assisted Drawing (CAD) of the prototype had to be optimized for real-time rendering and the controlling software connected to the virtual prototype. To test the viability of this UX simulation approach, it was not necessary to simulate machine behavior, thus only the Android GUI (not including the controller logic) needed to be included.

2.1 Android Emulation

The Android GUI for the simulation was sourced from a 2nd party contractor who supplied it as an Android Package Kit (APK), as well as specifications for the platform version, target screen dimensions and resolution. An Android Virtual Device (AVD) was set up accordingly through Android Studio.

For screen capture the open-source tool minicap[1] was installed on the AVD. Minicap provides a networked interface (specifically a websocket) to continuously capture screenshots of an Android device. Similarly, minitouch[2] was installed to enable iVR inputs to be sent to the AVD.

2.2 iVR Impementation

The iVR simulation was implemented in Unity 3D (version 2018.3.10f1) with the SteamVR SDK (version 1.4.18) to support iVR as Unity's own XR platform had not been released yet. The simulation established two separate websockets, enabling it to receive a continuous stream of screenshots (minicap) and to send pointer inputs as touch events to the AVD (minitouch). Screenshots were asynchronously read from the socket, then converted from raw byte data to Unity textures and applied to a plane in the scene.

Unity supports import to a texture as is, the only code required was handling the connection. Interaction was done through a virtual laser pointer originating at the controller. Inputs from the participants were captured as Unity UI events, accordingly transformed and then sent to the AVD. See an example for the input handling below and reference minitouch documentation for implementation guidelines.

[1] See the GitHub page for more details https://github.com/openstf/minicap.
[2] See the GitHub page for more details https://github.com/openstf/minitouch.

```
//Register a delegate to the OnDownEvent
//e being a stock EventSystems.PointerEvent.Data object
//containig pointer state at event time.
mImage.GetComponent<Clickable>().OnDownEvent
        += (e, translated) =>
{
//Pointer position needs to be translated from iVR
//screen-space to local space of the virtual
//GUI, then to the coordinate system
//of the emulated Android device.
    int[] coords = translatePointerData(e, translated);
    if (coords != null)
    {
//Writing the translated Pointer data to the mintouch
//socket (here wrapped in a StreamWriter object)
        m_InputWriter.WriteLine(String.Format(
            "d 0 {0} {1} 200", coords[0], coords[1]));
        m_InputWriter.WriteLine("c");
        m_InputWriter.Flush();
    }

};
```

Running both the AVD and iVR application locally kept latency minimal. For the experiment, four different scenes were designed, each only differing in placement and size of the GUI plane as the interface screen. The base set-up was made up of the virtual prototype, placed in an industrial workshop environment and a free-floating screen to display instructions. The first condition served as a control, with the screen in its original placement on the virtual prototype (10″), for the second, a medium screen (69″) was placed in in front of the prototype. The third condition was a large screen (~600″) placed behind the machine (see Fig. 1).

2.3 iVR Set-Up

The simulation was presented in a HTC Vive Pro HMD, interaction was facilitated through the index trigger on the default controllers. Only one controller was given to participants as no multi-touch inputs existed in the GUI. An approximately 3×3 m space was set up and covered by four HTC Vive Base Stations (version 2). Both iVR simulation and Android emulation was done by a Windows Computer with appropriate hardware.

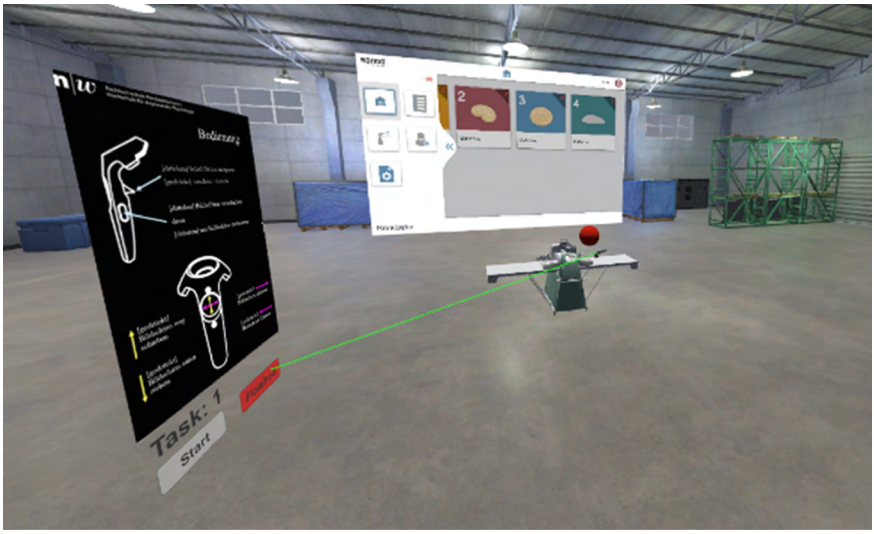


Fig. 1. 3rd Person view into the iVR scene, left screen showing tutorial and task information. Large screen behind virtualized machine showing the emulated GUI. Red sphere indicates participant head location.

3 Experimental Procedure

30 participants were recruited mainly from the body of psychology students at the University of Applied Sciences and Arts Northwestern Switzerland and were paid 30CHF for participation. Mean age was 26.93 and 21 participants identified as female (70%). Participants completed a questionnaire on technical affinity (TA) [2] and usage behavior of common online services (UB) as well as demographics prior to the experiment.

Participants were randomly assigned to three groups, each group starting with one of either the default screen, the medium screen or the large screen. After solving all three tasks, participants filled out a short version of the User Experience Questionnaire (UEQ-S) questionnaire [3] with items capturing sentiment towards the iVR environment as well as the emulated GUI. All groups then completed the same tasks again, this time with the option and instruction to freely place and scale the screen themselves and experiment with different positions and sizes. They again filled out the UEQ-S for their judgement of the individually place- and sizeable screen. Performance data was automatically collected, measuring total inputs made, time required, positional data among others.

4 Results

Three of the seven measured UX dimensions (supportive, efficiency, interesting) of seven were significant different between the default screen and the medium screen. Though there were no other differences and standard deviations were quite high for all scales. There were no significant differences comparing the screen condition with the judgement of the iVR environment. Overall judgement was positive, the lowest mean

score for the pre-positioned screens was 3.37 for complex (1) vs. easy (5) to use (SD = 0.809). Performance data showed that participants working with the large screen overall finished fastest and needed the least inputs (compare with Fig. 2). There was a significance correlation between the TA subscale competency and total time on tasks (−.378, p = .04). Other analysis did not reveal statistically significant relationships.

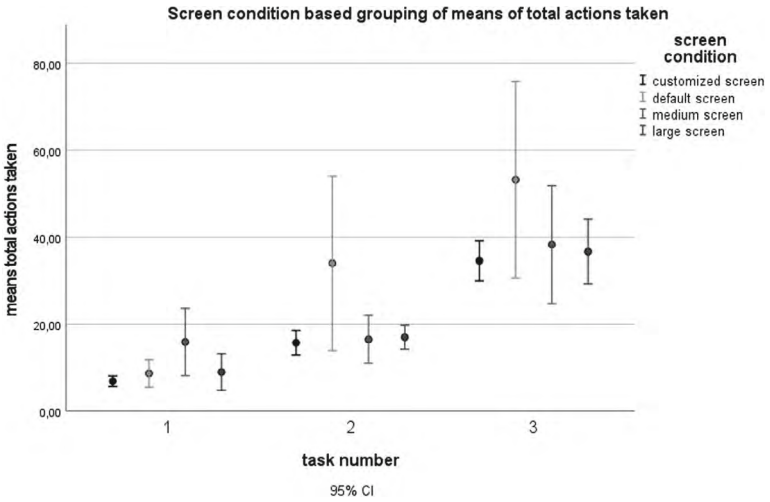


Fig. 2. Comparison of mean number of total actions taken by task and emulated GUI placement.

5 Discussion

The growing popularity of iVR with its decreasing costs make it possible to virtualize a plethora of processes. We think that XR testing, may be one of the most promising of these use-cases. This paper shows one example of how such virtualized testing can be implemented for an industrial prototype with an Android GUI and that it is received well with participants. Our result also indicate that screen placement need not be realistic and may even benefit from the freedom of placing and scaling that iVR offers.

We think evaluating GUI without a corresponding physical machine is a valid approach to UX evaluation. Further research into the validity of iVR UX testing is clearly needed to generalize these results. Given the great possibilities of cost-saving, shorter iteration cycles and experimentation in design, we see a lot of potential.

Acknowledgments. This study was done in collaboration with RONDO Burgdorf AG who provided the virtual prototype and GUI, as well as input regarding the economic relevancy of this kind of research.

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Influence of Input Devices on VR Sickness: Effect of Subtle Stimulation of the Sense of Balance on the Sensory Discrepancy

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Abstract. Simulator sickness is still an unresolved issue in the VR field. Especially in driving or flight simulators, a perceptual discrepancy often leads to nausea and dizziness. This study tested the assumption that a mild stimulus to the sense of balance prevents or reduces this discrepancy using a VRGo, which acts as a control in contrast to conventional tilt input devices. A trend towards reduction in both time to nausea and severity of symptoms of simulator sickness were found supporting this hypothesis.

Keywords: Simulator sickness · Motion sickness · Virtual reality · Driving simulation

1 Introduction

Motion sickness occurs due to a difference between actual and expected motion. Symptoms commonly include nausea, vomiting, cold sweat, headache, sleepiness, yawning, loss of appetite, and increased salivation [1]. While it was previously assumed that overstimulation of this system leads to motion sickness, it has been superseded by the sensory conflict theory, which suggests that the physiological component is not simply a single vestibular event, but that it represents the body's response to disharmonious/incongruent sensory information entering the brain. The theory induced by Irwin [2] was published in 1931 by Claremont [3] and has since been discussed in various journals.

In 1978 Reason [4] proposed a change to the existing sensory conflict theory. Until then it was assumed that a direct comparison between several afferent signals within the nervous system led to conflict and the associated nausea. The newly introduced hypothesis of neural discrepancy is based on the reference principle developed by Holst and Mittelstaedt [5, 6] and the sensory rearrangement theory of Held [7]. These were able to prove the neurological anticipation of what effects actions have on the sensory organs. For example, when we turn our head, we expect a shift in the field of vision. If the target state does not correspond to the actual state, a situation arises accordingly in which the

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 774–780, 2022.
https://doi.org/10.1007/978-3-030-85540-6_98

brain must carry out a sensory realignment. If there is a persistent difference or discrepancy between the actual information and the brain's expectations, and if this difference is of sufficient intensity, this leads to the neurovegetative reactions that is known as motion sickness. Reason [4] suggests that there may be many forms of sensory reordering that depend both on the circumstances at hand and on the sensory input modalities associated with them. Although Reason refers to six types of sensory reordering that could lead to motion sickness, he suggests that two main types are generally described according to the receptors involved: On the one hand, visual-inertial rearrangements, which include "inertial" both vestibular and non-vestibular proprioceptors, and on the other hand, (semicircular) channel otolite rearrangements. In both cases, two types of conflict could occur: In the first type of conflict, known as type 1, both systems send different signals simultaneously. In the second type of conflict, known as type 2, there is only information from one receptor, while information from the second is missing. Especially type 2a of visual-inertial rearrangement - where the eyes perceive movement, but the vestibular system does not respond to this stimulus - may explain why in immersive virtual reality (iVR) systems motion sickness may occur. Due to the growing availability of VR products and the predicted growth of the industry [8], various ideas for interventions to prevent motion sickness have been evaluated. Two popular examples are frame of reference and reduction of field of view. A frame of reference or orientation is a very popular method to fight VR disease. It involves adding a visual frame of reference to the image [9]. As a simple and inexpensive version, for example, a virtual nose can also be used, which serves as a fixed point [10]. A reduction of the field of vision also appears to be an effective remedy against kinetosis in virtual space, albeit at the expense of less immersion [11]. Widening the field of vision leads to increased postural instability, which serves as a substitute measurement for simulator disease [12]. Both interventions contain a manipulation in the perception of the virtual scene. Because this could have impact on the perception of immersion, presence and hedonic values, we investigated if the subtle stimulation of the sense of balance might have an effect on the prevention of motion sickness during a virtual driving task.

The aim of this quasi-experimental study is to find out whether subjects using a VRGo, compared to subjects using a Playseat and an accelerator pedal, can drive a virtual route for a longer period of time until they notice signs of VR disorder, and whether they show less aggravation of the symptoms described in the SSQ after the experiment.

2 Virtual Environment Methods

The already existing video game Project CARS of the Slightly Mad Studios from the year 2015 [13], was used as virtual environment. The Sonoma Raceway GP was chosen as the test track for getting used to the game, as the track has a rather narrow route and various tight curves, in which the test participants had to brake almost to zero. A test drive without time limit and VR glasses allowed the participants to get used to the game.

For the subsequent drive in virtual reality, the route California Highway Reverse was chosen. Due to its length, the increasing number of curves was chosen, as to see the effects of the associated braking and acceleration from section to section. To improve immersion participants drove a slower car with an interior similar to an ordinary one.

2.1 Measurement System and Response Time

The recording and output of the survey data took place via screen recordings and a specially written programme for time measurement, which was linked to the buttons on the control wheel.

For the present work, the time points until nausea, respectively until the end or abortion of the ride, were of particular importance. Accordingly, all time measurements and the calculation of the split times by the programme were accurate to the millisecond. The relevant points in time were the start and end of the test ride, the start of the VR ride, the exact point in time at which the test participant became unwell, and the end time of the VR ride. The end time could be either the time of the abort or the time of entry into the finish. The point of discomfort and the time of termination were activated by the test subjects themselves by pressing a button, while the experimenter activated the other points.

2.2 Hardware

For both groups, a Thrustmaster T150 RS control wheel was used, which was combined with a VRGo Chair in the experimental group and a Thrustmaster T3PA-Pro pedal set and a PlaySeat Gaming Chair in the control group. The virtual environment was created on a computer with an Intel i7-8700K processor and an NVIDIA GeForce RTX2080 TI graphics card before being displayed via an HTC VIVE Pro Eye. This hardware was selected based on its compatibility with each other and provided a secure rendering of the virtual world (Fig. 1).

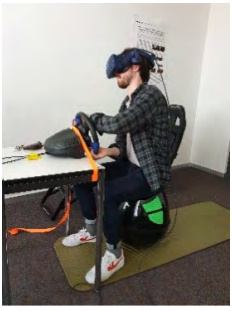


Fig. 1. Driving simulator with VRGo in use

2.3 Questionnaires

To allocate the sample in two different groups the shortened version of the Motion Sickness Susceptibility Questionnaire (MSSQ) [14, 15] was used during the acquisition. Immediately before the experiment, the Simulator Sickness Questionnaire (SSQ) by Kennedy et al. [16] was used, which distinguishes between 16 items that can be summarised into the three categories Nausea [N], Oculomotor [O] and Disorientation [D] as well as the Total Score [TS].

2.4 Acquisition of Participants

This study required relatively specific criteria for the trial participants. In order to measure whether VRGo had a positive effect on kinetosis, it was necessary to ensure that the subjects could become sick. Accordingly, people with a high MSSQ score were recruited in a preliminary survey. In addition to personal data such as gender and age, the questionnaire also collected aspects such as VR experience, illnesses such as epilepsy and the possession of a driving licence. From the 76 interested persons, 24 participants were selected, whereby it was ensured that the test participants did not have any impairing illnesses to ensure their health. For our experiment, we depended on the subjects having a MSSQ-score of twelve or higher. After the selection process, all those interested in the study were divided into groups based on their MSSQ total score according to the even-out principle and invited by mail. A total of 5 of the 24 invited subjects had to cancel for the experiment, of which only two could be replaced in time due to the criteria. Except for one case, where the appointment had to be cancelled at short notice on the day of the experiment due to a medical emergency, the group allocation could be adjusted in time.

Since it is ethically sensitive to deliberately make people nauseous and they were subjected to a slight deception (the subjects were informed before the experiment that this was an evaluation of the driving experience with the various input devices), the research design was reviewed and approved by the Research Ethics Review Boards of the University of Applied Sciences and Arts Northwestern Switzerland (Decision EAaFE2019004) in parallel with the preacquisition.

2.5 Experimental Procedure

For both ethical and time reasons, a quantitative quasi-experimental primary study without repeated measurements was chosen. Since different groups were used for the two conditions, this was a single-factor, univariate between-subjects design. Participants were instructed on the procedure, the device was set to its size, and the pre-test questionnaire was completed. After the training section, the subject switched to the virtual reality survey section before completing the post-test questionnaire.

2.6 Data Calculations

The statistical software SPSS (version 24.0) and Excel 2016 were used to analyse the collected data. $N = 10$ subjects used the VRGo, while $N = 11$ subjects used the Thrustmaster as an input device.

The data was tested for normal distribution (Kolmogorov-Smirnov test and Shapiro-Wilk test) as well as for variance homogeneity (Levene test). All the interval scaled data used passed both tests, allowing the use of an independent samples t-test. For the ordinal scaled data, the Mann-Whithey-U-test was chosen. The effect sizes of the results were calculated according to Cohen's d. A small effect is defined as $d = 0.20$. A medium effect is defined as $d = 0.50$ and a large effect as $d = 0.80$ [17].

3 Results

The variable *duration until nausea* was examined first. Descriptive data shows both mean and number of subjects with nausea symptoms were worse in the control group (M = 255 s, SD = 222 s, n = 10) than in the experimental group (M = 279 s, SD = 171 s, n = 6). No significant differences were found in an overall comparison of the means of the two groups ($t(14) = .226$, $p = .825$). Since various candidates with a low MSSQ total score did not experience nausea, it was further tested whether the grouping led to a significant difference in the occurrence of nausea. According to Fisher's exact test, this could not be confirmed ($p = .149$). Furthermore, it was examined whether statistically significant differences were evident when comparing the mean values of the test subjects with an MSSQ value of over 20, since in G1 all persons with a lower value (with one exception) made it to the finish without nausea. Even though the two groups now differed more (G1 M = 235 s, SD = 150 s, n = 5, G2 M = 137 s, SD = 152 s, n = 6), again no statistically significant differences could be found ($t(9) = 1.066$, $p = .314$). The effect strength according to Cohen is $d = .64$.

Despite the large differences between the mean values, no two-sided significance could be determined ($t(9) = -2.053$, $p = .0.70$). The effect strength according to Cohen is $d = -1.08$. One possible explanation for this tendency could have been immersion. After the times *until nausea* and *from the moment of nausea until termination* were examined, these values were now added together and compared again between the two groups. Since the two previous variables showed an opposite tendency, no statistically significant differences were expected here, which was also confirmed ($t(9) = -1.042$, $p = .325$). The effect strength according to Cohen is $d = -.63$. Since not all subjects dropped out of the experiment, the subjects who reached the finish line were examined in a further step. The descriptive statistics again suggested that there was no significant difference between the groups (G1 M = 625 s, SD = 48 s, G2 M = 631 s, SD = 76 s). This assumption could be confirmed ($t(8) = -0.133$, $p = .897$).

To assess whether the physical stress of the two groups was different, the changes between the pre- and post-experimental SSQ-scores was evaluated. The values could range from −3 to 3, with a higher value corresponding to a greater deterioration and a negative value representing an improvement. Significant differences were found for the following variables: *change in headache* (G1 median = −0.200, G2 median = 0.546, U = 24.000, p = .029) and *change in head pressure* (G1 median = 0.100, G2 median = 1.000, U = 25.000, p = .036). Except for *Eye strain*, *Difficulty seeing clearly*, *Increased salivation, Difficulty concentrating* and *Blurred vision*, there was a tendency for the experimental group to have less worsening of symptoms than the control group for all items of the SSQ. The greatest cross-group changes in the SSQ were in the variables *sweating* (increase of M = 0.948), *dizziness (eyes closed)* (increase of M = 0.8095), and *stomach makes itself felt* (increase of M = 0.8095). Furthermore, the data were calculated according to the score calculation of the SSQ the values of the respective head terms *Nausea* [N], *Oculomotor* [O] and *Disorientation* [D] as well as the *Total Score* [TS] and the new data were re-evaluated. No statistically significant differences were found in the scores between the two groups, neither before nor after the experiment. However, a tendency towards a lower deterioration was found in the experimental group compared to the control group for all 4 scores.

4 Discussion

The main aim of the present work was to determine whether even small stimulations of the sense of balance help to reduce or even prevent a sensory mismatch and whether this has a positive effect on VR disease. Although no statistically significant results were found in this direction, there was a tendency for people using the VRGo to reach the finish line more often and to feel nauseous less quickly. The lack of significance is largely attributed to the small group sizes, which was confirmed by extrapolations with G*Power and the big differences between participants in each group. Since there was an inverse tendency between the first signs of nausea and the time at which the subjects stopped the experiment, no significant differences were found in the time to termination.

The second part of the research question could be partially verified at the 0.05 level. In the categories *headache* and *head pressure*, a significance in favour of the experimental group could be achieved. Likewise, the differences in the categories *nausea, oculomotor* and *disorientation* as well as the *total score* were not significant, but all showed a tendency that supported the hypothesis.

Finally, it can be said that there is a tendency for both hypotheses to confirm the statement that even small stimuli on the sense of balance can have a positive effect on VR disease, although the experiment would have to be carried out with more test participants in order to be able to draw a final conclusion. According to extrapolations by G*Power, it should be possible to collect statistically significant data for some of the values studied, with at least 140 test participants. The effect sizes show us that additional sensorimotor information can lead to improved feedback processes through the agreement of efferences, reafferences, and the position sense (see effect boundary copy according to Holst & Michelstätt [5, 6] and model according to Reason [4]). This is of practical relevance since virtual training will increase [8] and motion perception should not negatively influence the success of a training. We hope that with this study we could contribute to the improvement of future iVR trainings in which motion perception plays a role.

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Adaptation of a Gaze-Aware Security Surveillance Support Tool for Augmented Reality

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Abstract. Operators monitoring closed-circuit television systems face many error-prone situations given the cognitive challenges they experience. The Scantracker is a prototype tool developed to support surveillance, relying on live oculometric data to trigger notifications that mitigate camera negligence, attention tunneling and vigilance decrement. To be robust and flexible, this tool must however collect valid gaze measures at a sufficient sampling rate and allow the display of surveillance-supportive visual notifications. This paper documents the integration of the Scantracker with the Microsoft HoloLens 2 augmented reality (AR) system embarked with eye tracking and reports a validity study performed in a high-fidelity surveillance simulation. The AR solution led to superior gaze validity than previous mobile or fixed oculometer integration. Implications of the solution integration are discussed and compared with the other implementations.

Keywords: Security surveillance · Eye tracking · Real-time measures · Intelligent systems · Human-systems integration · Augmented reality

1 Introduction

Closed-circuit television (CCTV)—systems comprised of several video cameras connected to a single output display unit—are a key tool for public safety. This technology enables techniques such as computer vision and face recognition to automatically identify threats or persons of interest from the camera feeds [1]. Yet, security surveillance still largely relies on human operators given their ability to detect new situations and to process complex information [2]. The supervisory monitoring tasks entailed by this work require constant focus for long periods of time, which is error-prone. Because errors such as failing to detect a suspect can have serious consequences, it seems critical to help operators to overcome the cognitive challenges they experience.

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 781–789, 2022.
https://doi.org/10.1007/978-3-030-85540-6_99

The development and integration of intelligent systems tailored to human cognition represent a key approach to support operators facing complex cognitive challenges in many work domains. A tool suited to support surveillance operators should then aim at reducing cognitive overload by highlighting neglected cameras and at mitigating attention tunneling and vigilance decrement, which are experienced in surveillance units [2]. To reach this goal, Thales Research and Technology Canada developed the Scantracker, a prototype gaze-aware system aiming at overcoming these challenges and supporting surveillance activities. Initially designed to rely on either mobile or fixed eye-tracking devices, this tool can trigger cognitive countermeasures to prevent: a) screen negligence; b) attentional tunneling; and c) vigilance decrement. The positive impact of these countermeasures has been reported by [3] and [4], mainly in the form of improved scanning behavior and better camera management strategies.

Oculometric data must be sent to the Scantracker to infer the gaze of the user, meaning that a commercial-off-the-shelf (COTS) eye tracker must be used. Initially, the Scantracker was created to operate with both a fixed (Smart Eye Pro 3D) and a mobile eye tracker (Tobii Pro Glasses 2). Although both functional, these solutions can be time- and resource-consuming given the necessity to integrate the countermeasures onto the surveillance unit interface. Moreover, to provide users with appropriate and timely notifications, these integrations must be fed by valid, reliable and accurate oculometric data. Yet, the manner by which 3D gaze location is inferred from these eye trackers in relation to areas of interest can lead to suboptimal levels of gaze data validity (see [5]).

Augmented reality (AR) is an interactive experience that could be exploited for the Scantracker. It is defined as the ability to provide a live augmentation of real elements of the physical environment via sensory inputs through a computerized solution [6]. Given the possibility to display information within the visual field of the user—and having been used for similar purposes to support complex tasks such as nuclear industrial operations [7], military combat simulations [8] and biomedical imaging [9]—this approach represents a sound solution for the Scantracker. Following design thinking workshops with subject matter experts and usability testing, the Scantracker was integrated with an AR technology equipped with eye-tracking capabilities to overcome the challenges pertaining to gaze data validity and notifications display [10]. This approach, however, had yet to be tested compared with the previous oculometer-based solutions.

The goal of this paper is to document the AR implementation of the Scantracker tool and to report its validity. First, we summarize the previous integrations that relied on the Smart Eye Pro 3D and the Tobii Pro Glasses 2 (i.e. the fixed and mobile eye-tracking integrations, respectively) and we describe how the new AR solution—contingent on the Microsoft HoloLens 2 device—can be used to display notifications, to model the surveillance environment and to detect the gaze position of the user. Second, we present the results of a validation study performed in the context of a high-fidelity surveillance simulation in which all three solutions were compared. Finally, we discuss the implications of the HoloLens integration compared to other solutions and suggest new functionalities that could support the cognitive work of CCTV surveillance operators.

2 The Scantracker Solution

The Scantracker is a java application which can track operators' visual attention on zones (different screens/areas) or on contents of interest (camera feeds regardless of the display zone) to send surveillance-supporting notifications. Its integration architecture and environment modeling technique vary according to the device with which it is used.

2.1 Oculometer-Based Integrations

The Scantracker can be integrated to send the notifications directly to the surveillance interface. The system receives gaze data by User Datagram Protocol (UDP) and, via a content streamer, sends data from the surveillance unit to the Scantracker which sends back notifications by Transmission Control Protocol (TCP). This approach relies on the live processing of eye-tracking data garnered via a fixed or a mobile eye tracker.

The Smart Eye Pro 3D system is a fixed eye tracker that can be mounted onto the workstation of an operator. It comprises four cameras recording at 120 Hz and five infrared flashes, which are considered highly reliable in terms of calibration and valid gaze data [11]. It possesses a built-in software allowing 3D-modeling of the environment according to the position of the cameras (see Fig. 1, left). This component enables to identify the location of the monitors and of the user's gaze within the environment.

The Tobii Pro Glasses 2 device is a head-mounted eye tracker using four 50 Hz infrared cameras that is deemed very simple to set up and to use despite some precision limitations [12]. Because it is not equipped with a built-in module modeling the 3D environment, an external solution must be used to infer the location of the user's gaze. Hence, a computer vision technique based on Open CV, a solution for image processing, is used to detect the user's gaze. It relies on 2D target markers (hexagonal or octagonal) serving for geo-spatial positioning at a 12.5 Hz recording rate with the system's frontal camera. As long as a visual marker is detected, the system can infer the 3D pose of the objects and superimpose the gaze while accounting for scene depth (see Fig. 1, right). Although the Tobii Glasses solution provides mobility to the user (as opposed to the Smart Eye integration), it can also lead to poorer gaze data in situations where the environmental markers are undetected by the computer vision algorithm [5].

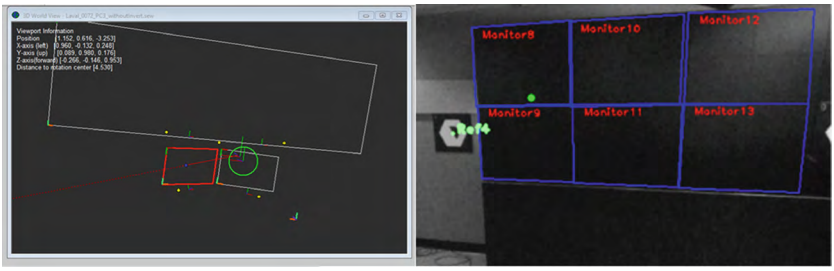


Fig. 1. Modeling of the environment using the built-in software of the fixed Smart Eye (left). Marker-based environment detection for the mobile Tobii Glasses (right).

2.2 AR-Based Integration

The architecture of the Scantracker AR integration relies on a Message Queuing Telemetry Transport (MQTT) protocol, a lightweight, publish-subscribe network protocol that transports messages between devices. In this version, the Microsoft HoloLens 2 device provides gaze information to a Scantracker app developed for the HoloLens. This app sends via UDP protocol raw eye-tracking data to an external component named Sensor Hub, which analyzes them in real time for the vigilance model. Content of the surveillance interface can be sent to the Scantracker software via TCP protocol from the surveillance unit. Finally, communication between the HoloLens Scantracker app, the Scantracker software and the Sensor Hub is managed by MQTT to transfer gaze information to the Scantracker software and to send notifications information to the HoloLens Scantracker app. Gaze of the user is collected at a 30 Hz recording rate but sent to the Scantracker at 25 Hz. The eye-tracking component of the HoloLens 2 relies on two infrared cameras and a 1-MP Time-of-Flight depth sensor. Their expected accuracy is $\pm$ 1.5° in visual angle which is poorer than other wearable eye trackers [12].

The environment of the user is modelled through the HoloLens Scantracker app. This app supports two operation modes: preparation and standard. The former allows to configure the real-world scenes that are monitored by the user while the latter allows tracking of the operator's gaze and display of the notifications. To identify where the notifications will be displayed within the environment, one must use the preparation mode and select scenes of interest that can ultimately be subdivided into several camera display areas (or zones) that will receive the notifications (see Fig. 2). Note that the zones can be defined in a configuration file according to their x- and y-coordinates within the selected scenes. Then, the Scantracker can present the notifications directly into the visual field of the user, onto the specific zones, through AR when instances of negligence, attention tunneling or vigilance decrement are detected. They are presented through the holographic lenses at a 2k 3:2 light resolution with a density > 2.5k light points per radian.

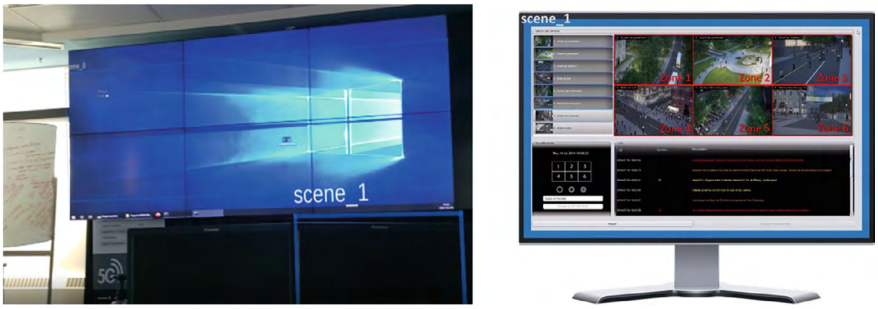


Fig. 2. Preparation mode examples for scene definition (blue frames) for the HoloLens integration in a simulator in a surveillance microworld, onto a video wall and a computer monitor (left) and for zone identifications (in red) within a specific scene (right).

3 Empirical Evaluation of the Tool Validity

3.1 Method

Participants. One hundred and twenty-two subjects (78 women, 44 men) with a mean age of 26.26 years ($SD = 6.78$) took part in a single 120-to-180 min session with a small honorarium in return. They all reported normal or correct-to-normal vision and hearing.

Material and Procedure. Participants performed a simulated surveillance task using the "Cognitive Solutions for Surveillance in Security" (or CSSS [13]) testbed. This high-fidelity simulation environment comprises an operator workstation containing two monitors and a large video display wall. It contains a surveillance interface of eight cameras with only six display zones that are both presented on one of the monitor and on the display wall. The wall and the second monitor depict a map of the area to monitor and fake TV news. The simulated scenarios represent computer-animated crowd scenes at different area locations. Subjects performed five 16-min scenarios. They were asked to look for any suspect behavior and to detect and report 29 preprogrammed incidents.

During the simulation, subjects were all monitored by the Scantracker system (see Fig. 3). Thirty-five of the participants wore the Tobii Pro Glasses 2, another 35 were monitored by the Smart Eye Pro system and the other 52 were supported by the AR implementation using the Microsoft HoloLens 2 device. Note that preliminary results of the first four scenarios for the 70 participants monitored by the two eye trackings were presented in [5]. In the present study, we aimed at analyzing the impact of the devices (i.e. Smart Eye, Tobii or HoloLens) and of time (i.e. along the scenario blocks performed) on gaze data validity of the Scantracker (i.e. the amount of valid oculometric data, in %). We also examined the effect of the architectural systems on the gaze data recording rate (i.e. the number of data captured by the system, in Hz) by assessing whether this rate changed over blocks and if it differed from the expected rate.



Fig. 3. Experimental setup of the CSSS microworld with the previous eye-tracking integration (fixed Smart Eye or marker-based Tobii Glasses; left) or with the AR system embarked with eye tracking (HoloLens 2; right).

3.2 Results

Fourteen subjects were excluded because of missing data. Gaze data validity was analyzed using a 3 (Device; Smart Eye, Tobii, or HoloLens) × 5 (Block; 1–5) mixed Analysis of variance (ANOVA). For each device, between-blocks differences in recording rate were assessed using repeated-measures ANOVAs. Recording rate was also averaged across blocks and compared with the expected value using one-sample *t*-tests.

Figure 4 depicts the measures of gaze data validity for each block and device. The mixed ANOVA uncovered a significant main effect of Device, $F(2, 105) = 89.18$, $p < 001$, $\eta^2_p = .63$, of Block, $F(4, 420) = 21.39$, $p < .001$, $\eta^2_p = .17$, and a two-way interaction, $F(8, 420) = 28.41$, $p < .001$, $\eta^2_p = .35$. Further tests showed that except for the Tobii-Smart Eye difference at block 1 ($p = .095$), all block differences on these devices reached significance. No decrease in gaze data validity was observed as a function of blocks for the HoloLens ($p = .998$) and Smart Eye ($p = .542$). Yet, except between blocks 4 and 5 ($p = .568$), the validity of the gaze data of the Tobii integration significantly depreciated as a function of blocks, i.e. while time on task increased.

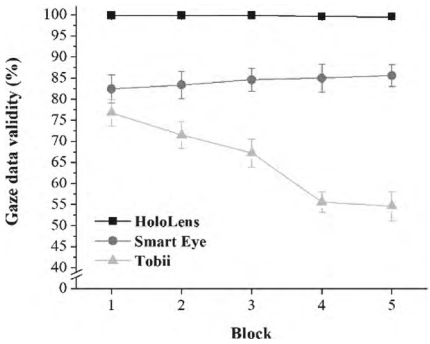


Fig. 4. Average gaze data validity (in %) for the three device as a function of the block. Error bars represent the standard error of the mean.

Analysis of the recording rate of the gaze data across blocks (see Table 1) raised no block differences for all the device integrations (Fs < 1.45, ps > .241). The mean rate for the Smart Eye solution ($M = 102.94$ Hz, $SD = 11.52$) differed significantly from the expected value of 120 Hz ($p < .001$, Cohen's $d = -1.48$). With a lower effect size, the same result was observed for the HoloLens solution ($M = 24.52$ Hz, $SD = 0.90$) relative to the 25 Hz expected value ($p < .001$, Cohen's $d = -0.53$). No significant difference was found for the Tobii implementation ($p = .089$, Cohen's $d = -0.31$).

Table 1. Gaze data recording rate (in Hz) for the three device integrations across the blocks (mean and *SD*), results of the between-blocks ANOVAs and results of the one-sample *t*-tests of the comparison with the expected rate values.

Device	Block					*F* (blocks)	*t* (rate)
	1	2	3	4	5		
Smart Eye (120 Hz)	105.39 (8.52)	104.22 (8.53)	103.70 (8.98)	103.27 (10.50)	104.13 (7.18)	1.44	−8.38***
Tobii Glasses (12.5 Hz)	12.48 (0.01)	12.48 (0.01)	12.48 (0.01)	12.48 (0.01)	12.48 (0.01)	1.32	−1.75
HoloLens (25 Hz)	24.66 (0.14)	24.68 (0.14)	24.60 (0.32)	24.73 (0.50)	24.55 (0.70)	1.27	−3.85***

*** $p < .001$

4 Discussion

The current paper first aimed at presenting how the Scantracker—a gaze-contingent surveillance support tool—could be integrated with the Microsoft HoloLens 2 AR device. As explained above, the new AR solution allows to display the surveillance-support notifications directly into the field of view of the user, rather than onto the surveillance unit interface, which requires resourceful integration. Through a tailored HoloLens application that we developed, we could identify zones of interest within one's visual environment. Then, the Scantracker—by receiving gaze data from the HoloLens tool—could send back information regarding the content that was gazed upon and, when appropriate, could send notifications into the user's field of view. The second goal was to assess gaze data validity of this AR solution compared with a former version relying on a fixed (Smart Eye Pro 3D) and a mobile (Tobii Pro Glasses 2) eye tracker. This was examined through a surveillance simulation in a high-fidelity testbed (i.e. the CSSS [13]). Results of the experiment showed that the gaze validity of the AR solution outperformed that of the two other solutions through all the blocks of scenario. Moreover, contrary to the Smart Eye and HoloLens integrations, the gaze data validity of the Tobii solution depreciated over time. Interestingly, a reduction in data recording rate was observed for the HoloLens and the Smart Eye, the effect being greater for the latter.

The quasi-perfect gaze data validity observed for the HoloLens solution suggests that this device's eye tracker is highly reliable. The Smart Eye solution can miss data when the user is outside the field of the cameras while, for the Tobii integration, this happens when a visual marker is either occluded or missing. The HoloLens device is embarked with oculometric capabilities located under the eyes and that directly communicate with the system's environment model. Interestingly, this high validity was maintained across time, contrary to the Tobii solution for which one may become less aware and focused to ensure the constant presence of a target marker in their field of view. Noteworthy is also the fact that recording rate decreased specially for the Smart Eye ($M = 102.94$ Hz) and HoloLens ($M = 24.52$ Hz) components. This decrease was probably contingent on the specificities of the systems architecture or the data recording pipeline. Although not problematic for

the Scantracker per se, one might need to consider the sampling rates of all these solutions before integrating rapidly-paced ocular measures (e.g., microsaccades, nystagmus or high-frequency pupillary variations) given the known impact of frequencies < 200 Hz for sampling errors [14].

Overall, this study highlights the potential of using AR technologies to help surveillance operators overcoming the cognitive challenges they typically experience [2]. AR is a technology that is becoming accessible and that is applied to multiple domains to support human work (see [7–9]). It can thus be harnessed to develop a solution that is agnostic (i.e. independent) from any technology that is used to display the monitored content. The AR approach therefore presents a lot of potential for facilitating the integration of a solution such as the Scantracker in virtually any work environment using an affordable COTS technology. This also suggests that the Scantracker solution could be applied to other work contexts (requiring monitoring of different types elements) where issues related to vigilance decrement, content negligence and attention tunneling might be problematic. Yet, one must consider the lower accuracy of the HoloLens' eye-tracking capacity ($\pm 1.5°$) which could mitigate the Scantracker ability to correctly infer the gaze position of the user on smaller or distant content.

One of the key benefits of AR combined with real-time gaze analysis is its potential for the development of functionalities to support users from any work domain pertaining to visual monitoring. For instance, AR could confer the possibility to depict the content that was most observed during a work session (i.e. a heat map), directly superimposed on the visual field. An interface depicting some behavior statistics (e.g., number of notifications or time elapsed to cover all the content to monitor) could also be helpful for operators. Future work will thus aim at improving the support provided by the notifications and at developing new functionalities to enhance user experience.

Acknowledgments. This project was supported by a grant from the Innovation for Defence Excellence and Security (IDEaS) program and by Mitacs Canada. We are grateful to all the participants involved in the workshops and data collection. Thanks are due to François Vachon, Vincent Poiré, Laura Salvan, Noémie Lemaire, to the Thales development team and to the research assistants from Université Laval.

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Learning in Immersive Virtual Reality: How Does the 4E Cognition Approach Fit in Virtual Didactic Settings?

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Abstract. Immersive virtual reality (iVR) is becoming increasingly popular in the field of learning. However, due to the large number of scientific publications, it is questionable whether a substantial increase in knowledge in the use of this technology faces a manageable number of challenges. The question of the theoretical-conceptual embedding in the state of the art of psychological learning research (4E Cognition) must also be examined in order to enable the optimization of future iVR learning applications.

Keywords: Immersive virtual reality · Systematic review · Learning · 4E Cognition

1 Introduction

Head Mounted Display, the new generation of immersive virtual reality, have been available in regular retail stores since 2015 and research has been conducted in the area of learning in immersive virtual space. According to Statista's forecast as of March 2019, sales of HMDs are expected to increase to 69 million units in 2023 compared to 8.9 million in 2019 [11]. According to IDC (International Data Corporation), 160 billion will be invested in AR/VR by 2023, including 8.5 billion in training [9]. Like the technological innovations in VR, many fields, including education, will change and progress permanently, and it is advantageous to know the potential of the new technology in its "state of the art" pedagogical context. Therefore we aimed to create a systematic review of learning outcomes in immersive reality under the condition of integrating the newest 4E Cognition learning approach. The classic postulates of cognitive psychology in learning focuses on the brain as the exclusive "organ of thought". The derived studies in experimental laboratory context are critically discussed as too reductionist - currently especially by representatives of the so-called 4E Cognition approach in cognitive science [8].The 4E Cognition approach [8] emphasizes the role of the physical body (embodied cognition), the interaction between the individual and its environment (extended cognition) as well as aspects of acting in social interaction (enactive cognition) and the situatedness of cognition (embedded cognition).The current 4E Cognition

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 790–796, 2022.
https://doi.org/10.1007/978-3-030-85540-6_100

approach, especially in learning, postulates a holistic approach to the complexity of cognitive phenomena in everyday life. Cognition (i.e. perception, thinking, problem solving, decision-making, language and action) is understood as reaching beyond the individual human brain: The arguments of the 4E Cognition approach are based on current neuroscientific findings and practice-oriented approaches to complex actions (e.g. qualitative analyzes of observed cognitive processes in the cockpit of an airplane when it lands) [3]. In more detail the assumptions include:

1.) Embodied: The body (extracranial - outside the brain) is a constituent part of "cognition". The dynamics of brain-body-environment feedback processes are central. Cognitive phenomena are closely related to physical (biological, physiological, morphological) details and bodily changes [12].
2.) Extended: Cognition involves the interaction of humans with the structure of their natural, technical and social environment [3]. Thinking, cognitive processes extend through the interaction with objects, (intelligent) tools and other people.
3.) Enactive: Cognition extends to active action in and with the environment of an individual. "… there is no line that cuts the organism off from these other social and environmental factors" [8].
4.) Embedded: Cognition includes a close connection with environmental variables outside of the acting individual - with the situation [5].

The possible application of the 4E Cognition approach to learning systems in VR is the aim of the review, which was done according to PRISMA Guidelines. First, we analyzed success-factors and challenges in VR training. Second, we discussed potential didactic settings and give a perspective of what future application need to fit in the 4E Cognition approach.

2 Methods

2.1 Literature Review

We searched different databases and only included RCT Studies (random controlled trials) to ensure methodological correctness. We created criteria of inclusion and exclusion and found over 2000 papers in the first round. After elimination of duplicates and exclusion of studies with non-stereoscopic (immersive) VR with head mounted displays (HMDs) we had 37 studies that were included in the analysis. In Fig. 1 the process of the review according to PRISMA guidelines is documented. The search string used for the search in all databases is (immersive virtual reality OR head-mounted display) AND (education). The chosen search string aimed to find results in the field of education and a focus on the high immersion generated by HMDs and other learning environments declared as (Learning in VR). The selected databases were IEEE Explorer, Scopus & Pubmed.

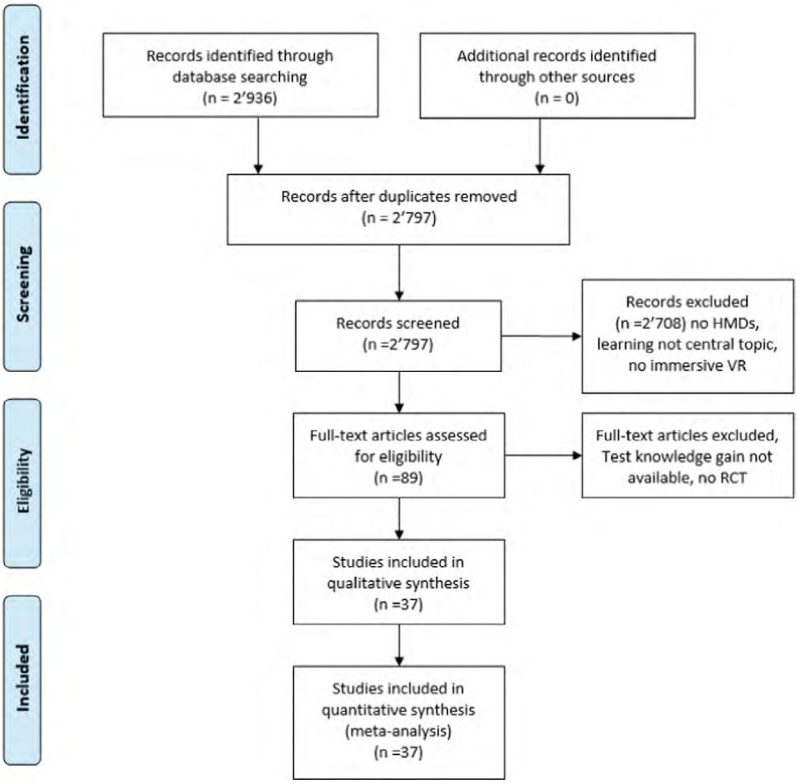


Fig. 1. The PRISMA Flow Chart of our review. After the first identification and the removal of duplicates 2797 articles were screened: First, studies with no HMDs, no immersive VR and learning as a central topic were excluded. Second, no RCT (random-control-trials) studies and studies without a dependent variable that describes the knowledge gain were excluded. After this proof of eligibility 37 articles were included in the analysis of success factors and challenges. After this the fit to 4E Cognition was done.

2.2 Fitting of 4E Cognition Dimensions

Two authors reviewed the fit of the 4E Cognition dimensions independently. We then discussed the results based on our findings. Our approach was not excluding an impression. Rather we aimed to maximize diverse opinions. This in order to grant the breadth of interpretive possibilities and to promote scientific discourse. Certainly, this approach is debatable. However, we consider it necessary as a first step.

3 Results

In this section we describe first a selection of studies to describe the partial impression we had when viewing the articles (success factors and challenges). Second, we show our attempt to place the dimensions of 4E Cognition on the content design of the iVR trainings. Some studies [1, 2, 4, 6, 10, 13] have examined the effectiveness of iVR in the

context of the medical field. The studies examined how the new method of knowledge transfer (IVR) compares to traditional methods (frontal teaching, self-study books and paper-based learning materials). The following studies found a positive effect of using iVR on the knowledge growth of students [1, 2, 4, 6]. The following study did not find a positive effect on knowledge growth of learners [10] but the method is not subject to traditional learning through traditional learning material. The testing of knowledge gain in the studies was tested either by knowledge quizzes created specifically for the study or by a validated knowledge quiz after the intervention.

3.1 Success Factors

The success factors found by the authors are now listed below: [1] suggest that simplicity, usefulness and perceived pleasure determine the efficiency of learning success. Limitations are, that there was no real evidence in the article itself and the SUS was used to determine usability. We are uncertain if this is relevant to learning outcomes. [2] demonstrated a different view: VR-trainings should be flexible and personalized for different teaching and learning styles. Specifically, it means self-directed learning by students and optimal use of instructor time and feedback. [6] sees the great advantage of VR that the relative size and proximity of the simulated object (heart anatomy) corresponds to the real one and can be viewed by students. Traditional methods use cadavers to convey this knowledge, but the size relationships are made impossible by destructive dissection. Another advantage of VR is the multi-layered representation in virtual space. Further, [6] see the interaction with the 3D model as an advantage for medical education, because students can build up self-confidence and familiarity. Another important aspect is the fun of learning which is enhanced by the use of VR (User Enjoyment). As [2] have already stated, [6] see self-directed exploration in the AER (Virtual Reality Environment) as beneficial for problem-based learning. [4] also showed that students described simplicity and fun motivating and that this fact has positively influenced learning efficiency. Like [2, 4, 6] attribute success to the self-directed way of conveying knowledge in VR. The reasoning is, as in [6], that it is advantageous for problem-oriented learning in the medical field. Further [4] assume that the immersive nature of VR and the possibility of interaction and direct manipulation of virtual structures is positive for student learning. [10] found positive effects in subjective measurements in their study. Commitment, enjoyment (fun), usefulness (usefulness), learner motivation was superior to conventional methods. These factors should not be neglected and speak for the use of VR in the learning context. [13] found that individuals with less basic knowledge benefit more from VR learning environments. Furthermore, for the students, the holistic representation of the physiological system was helpful for knowledge growth. When designing VR content, [13] suspect advantages in the static presentation and sparse use of short notes on the anatomy to be learned. They base this on the Cognitive Theory of Multimedia Learning by [7]. A flood of information via the visual channel can therefore make learning difficult, as only a limited bandwidth is available, concludes [13]. As other authors mentioned above, [13] see self-directed interaction with VR content as a success factor.

3.2 Challenges

Challenges according to [2] are as follows. Teaching institutions in the 21st century should ideally become curators of learning content. The challenge is to filter, group and adapt learning content that complements what already exists. Standards for the implementation and evaluation of VR (hardware and software) are in demand. [6] see a hurdle for the implementation of VR as a learning method in the still high costs of VR. The economic measure of cost efficiency has become as important for universities as it is in the private sector. [4] see the individual development of three-dimensional perception as a hurdle. Individuals with a strong three-dimensional perception benefit most from VR learning environments and training. Another stumbling block according to [4] in the use of VR for learning is the phenomenon of cybersickness. The manifold aversive physiological consequences could cloud the experience or make it impossible. [10] found no significant advantages in using VR compared to conventional learning methods. The post-test of knowledge retention was performed 2 months later. Therefore, positive results are still to be considered critically and more research on long-term effects is needed to ensure an optimal use of VR in the learning context.

3.3 Fit of 4E Cognition Approach

As the results show, the majority of studies can be mapped to several dimensions of the 4E Cognition Model (see Table 1).

Table 1. The fit of the articles included in the systematic review and the 4E Cognition dimensions: embodied (Embo), Extended (Exten), Embedded (Embe), Enactive (Ena)

Article	Dimension 4E Cognition
Andreasen et al. (2019)	Embo, Exten, Embe,
Adams et al. (2019)	Exten, Ena
Kozhevnikov and Gurlitt (2013)	Embo, Exten Embe
Yang et al. (2020)	Embo, Exten, Embe, Ena
Zhao and La Femina (2020)	Exten, Ena
Chua et al. (2019)	Exten, Ena
Harrison (2017)	Embo, Exten
Bagher et al. (2020)	Embo, Exten
Johnson-Glenberg (2020)	Embo, Exten, Embe
Wong et al. (2019)	Exten
Yu and Lin (2019)	Exten
Stepan (2017)	Exten
Maresky et al. (2018)	Exten

(*continued*)

Table 1. (*continued*)

Article	Dimension 4E Cognition
Frederiksen (2020)	Embo, Exten, Embe
Markowitz et al. (2018)	Embo, Exten, Embe
Pulijala (2018)	Embo, Exten, Embe
Hooper et al. (2019)	Embo, Exten, Embe
Yoganathan (2018)	Exten
Berg (2020)	Embo, Exten, Embe
Harringten et al. (2017)	Exten
Ros et al. (2020)	Embo, Exten, Embe
Kurul et al. (2020)	Exten
Zinchenko et al. (2020)	Exten, Embe
Mills (2019)	Exten, Ena
Dunnagan (2020)	Embo, Exten, Embe, Ena
Kim et al. (2020)	Exten, Embe
Meyer et al. (2019)	Exten, Embo
Makransky (2019)	Embo, Exten, Embe, Ena
Lin and Wang (2019)	Embo, Exten
Chang et al. (2019)	Exten
Taranilla (2019)	Exten
Lohre et al. (2020)	Embo, Exten, Embe
Smith et al. (2018)	Embod, Exten, Ena, Embe
Adolf et al. (2019)	Exten, Embe
Baceviciute et al. (2020)	Exten, Embe, Ena
Chowdhury et al. (2017)	Exten
Cabrera et al. (2019)	Exten

4 Discussion

The aim of this review was on the one hand to present the success factors and challenges of iVR trainings, and on the other hand to question the fit of iVR trainings to the theoretical-conceptual and finally also didactic settings according to the 4E Cognition approach. Our impression is that the most iVR- training studies fit to more than one dimension of the 4E Cognition approach. We were able to show that the frequencies of the different dimensions vary. In the ranking from highest to lowest the dimension extended was placed in all studies. It was followed by the dimension embodied, which was placed 18 times. After this, embedded was placed 17 times and the dimension enactive could only be placed 9 times. The dimension extended is described in its property with: “cognition

involves the interaction of humans with the structure of their natural, technical and social environment. Thinking, cognitive processes extend through the interaction with objects, (intelligent) tools and other people". Since iVR thrives on interaction with the objects, avatars and people in the virtual space, it is not surprising that this dimension most often fits the studies analysed. It is also the case that VR glasses without interaction mechanisms do not exist in commercial sales. The dimension with the lowest fit is described as: "Cognition extends to active action in and with the environment of an individual… there is no line that cuts the organism off from these other social and environmental factors". Now, active involvement in simulated worlds is only possible to a limited extent, so that it feels "natural". The challenge in iVR worlds is precisely to create presence and immersion. It is clear that this cannot always be achieved or that unnaturalness ("I can walk through walls") does not always mean a natural feeling of immersion, but it does not have to be a disadvantage in learning. Using this last concept as an example, we see the greatest need for further development both for research and for the development of applications for learning practice. Further studies will show what conceptional dimensions of the 4E Cognition approach are mandatory for the successful learning in a iVR environment.

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Methodology for the Development of Computer Applications with Augmented Reality in the Tourism Sector

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Abstract. This study analyzes studies that have a methodological basis in the development of computer applications for the area of tourism supported by augmented reality technology. Augmented reality has proven to have great potential in learning due to its high level of visibility and interaction. The problem is the lack of research on development methodologies, supplementation of information for users with augmented reality, other alternatives in steps that allow the integration of image information in the tourism sector. The objective is to propose or adopt a methodology for the development of computer applications with augmented reality in the tourism sector. The methodology used in this proposal is oriented in analytical and exploratory research for a review of research work on the subject and theoretical proposal. After conducting the bibliographic analysis, the result was a Mixed methodology prototype for the development of computer applications and a general algorithm of methodology. It was concluded that, in the proposed methodology, the amount required in functionalities, data management processes, and codes of an application influence the development of computer applications; Augmented reality has great potential in many areas, tourism is a good application option for its features and benefits.

Keywords: Software development methodology · Computer applications · Software engineering · Augmented reality · Tourism sector

1 Introduction

Information and Communication Technologies (ICTs) make it possible to make software development, project, and group management easier for the distribution of tasks or responsibilities, all under standards of independent software development of geographical distance and with collaborative tasks in a working group [1]. It is important to choose a development methodology for the good completion of the project, if a methodology is not applied there are problems, increased costs, increased times, inefficiency, and uncontrollability; other kinds of literature consider it important to use a methodology to improve quality, increase resource efficiency and agility in the development team [2], other authors consider it a problem not to apply software engineering; and

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 797–804, 2022.
https://doi.org/10.1007/978-3-030-85540-6_101

focus on optimizing development, reusing code, minimizing requirements, optimizing methodology times and increasing profitability [3]. The development of computer applications is established within costs, times, and resources to achieve the delivery of a safe product and quality; IT specialists have knowledge challenges in the business or area to be developed; each methodology has its strengths and weaknesses that professionals must select according to the project or team training [4]. According to [5], among the 3 main reasons to adopt a methodology are: improve the software, improve the quality and improve the relationships of the group. Software Engineering is a complex area, this has two sensitive factors; the first is the human factor that has interaction between people, communication, and behaviors; the second is the technological factor [6]. According to [7] there are the following criteria for the successful completion of the software: Low cost in initial development; easy software maintenance; software must be multi-hardware and multi-operating system; and meet the requirements. Augmented reality as a support technology, allows adding in the real world different forms of interaction such as aggregation of voice, text, images, animations, and other data that serve as information about the camera of a device [8]. It is claimed that many of the augmented reality applications in the tourism sector begin as a research project; the internet, geolocation, image, and marking are major assistance in tourism [9]. The problem is the lack of research on development methodologies, supplementation of information for users with augmented reality, other alternatives in steps that allow the integration of image information in the tourism sector. The research question is: Why is a methodology needed for the development of computer applications with augmented reality in the tourism sector? In response to the question, it is necessary to understand the activities of control and success in the development of software that applies augmented reality; then understand the impact of augmented reality on the tourism sector. The objective is to propose or adopt a methodology for the development of computer applications with augmented reality in the tourism sector, for this, a bibliographic review is carried out to determine a methodological proposal based on the revised studies.

2 Materials and Methods

The methodology used in this proposal is oriented in analytical and exploratory research for a review of research work on the subject and theoretical proposal. The search is carried out in the search engines: IEEE Xplore and Scopus, considering the inclusion and exclusion criteria detailed in Table 1.

To obtain the minimum components to propose a mixed methodology, from this, a total of 12 articles were obtained, of these 9 references were discarded because they presented applications of traditional methodologies in cases of software development, staying with 3 references that they provided with our research objective.

Table 1. Inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
- Relationship with keywords - Documents that present methodologies, algorithms, Framework, among other proposals - Documents with qualitative or quantitative proposals - Documents in Spanish or English language	- Secondary or lower-level documents such as non-official web pages, regional or national magazines - Documents before 2017

3 Related Works

Below are the related works that are part of the analysis of this research, on the one hand, the methodologies used by different authors and on the other hand the applications that have been developed with RA in the area of tourism.

3.1 Methodologies for Development

Some methodologies or processes used as: [1] describes that several development groups used agile methodologies, project management, and engineering, to maximize communication, control, and distribution of tasks. [3] It details important attributes in software quality such as functionality, maintenance, scalability, efficiency, reuse, portable, and performance. According to a survey of [4] among 144 works in software development, it was found that the most widely used methodologies are Agile and Lean for their flexibility and adaptability. In [6] the authors conducted a survey and concluded that it is necessary to use development methodologies in the academic and research area to focus on solutions through good practices. The authors of [7] established 6 criteria for selecting an agile methodology such as internet/company representation, documentation, training, support groups, and development projects. In [10] a list of thirty criteria distributed in seven qualities to select a development methodology is defined, to support the research they presented software based on the selection of a methodology. Moreover, [11] proposes 10 fuzzy inference rules to select a development methodology, this technique scores the rules and is implemented in Matlab software. In [12] a hybrid perspective consisting of other methodologies for selecting a methodology for mobile application development is presented. The proposal of [13] uses multiple criteria and makes decisions based on software quality and maintenance values. In [14], Interesting is the type of methodology used through distributed development, this consists of cost reduction, time reduction, quality increase, increased performance. For small and medium groups or individual developers during application encoding; the methodology set out in [15] for the development of safe and quality software. In [16] engineering cores are proposed in four-stage development models to minimize complexity and separate key areas. In [17] an agile and hybrid methodology was proposed that has an interest in people, interactions and self-management.

3.2 Assistive Technologies

Some supportive technologies or used in tourism are BASED on GPS [18], web applications [19] and [20], artificial intelligence [21], web services [22], data extraction and datamart [23], virtual reality [24] and [25], mixed reality [26], 5G communication [27], among others. It is necessary to take advantage of this large amount of influx to apply augmented reality to this sector due to its great potential within the area of tourism. The following documents are researched using Augmented Reality in tourism: A prototype was made for tourists in [8]; here a process detects the image and converts it to an array to get objects from the captured environment. In [9] describes the resources used for an augmented reality project; including the computer/tablet/cell phone, a grapher, a development kit, and 3D animation software. In [28] an architecture was proposed that offers 3D tours of ancient or archaeological sites; objective marking is also used to process the place to be toured. In [29] the authors developed an augmented reality architecture; it captures the image, then processes its capture, localization protons, accesses the resources of the captured location and reproduces the augmented image with the captured locations. The authors [30] developed a mobile app with augmented reality in churches.

4 Results

4.1 Mixed Methodology Prototype for the Development of Computer Applications

Based on the 3 bibliographic references used, the most relevant characteristics of each of them are detailed below. This is, [15] offers quality and security in software development, has proven methodology for small and medium-sized groups in areas such as health, education, government, and markets; [16] presents an engineering methodology to manage the development of complex system architectures, each discipline requests the status of each core to execute an effective plan in the construction of the architecture, and [3] based on agile and quality software development, attributes are important with the vision of having quality software; these attributes are linked to development processes and conversely. Based on the above, a methodology is proposed to form a mixed guide in the development of applications related to the use of augmented reality: it was adopted of [15] the six phases for software development and quality practices at each stage; of [16] disciplines that assist in software development and progress were adopted, it is focused on four disciplines: analysis, design, verification, and measurement; of [3] five-phase distributed quality attributes were adopted for software development.

The following explains in detail the phases, disciplines, and attributes adopted in the three references:

a) **Pre-analysis phase:** Identifies the users involved in the process, here are government entities, sectional governments, personnel from tourist areas; determine functional and non-functional requirements; in macro processes is the analysis of tourist sites, photos of tourist sites, inventory of activities, prices, comments, capture coordinates,

coordination with social networks; in the identification of standards is the development platform, databases; the opportunities that can be generated for the tourist site; beneficiaries identify facilities and people that receive tourists to generate possible economic movements; impact is measured in the number of visitors, the number of jobs, amount of money, average visiting days.

b) **Requirement's phase:** Requirements include access to offline information, version updates, data link with social networks, update of tourist site activities to review, GPS access, tourist alerts, store positioning, planning activities with tourist sites, guides, among others. Identification of potential needs recommends using surveys to locate solution alternatives; resources should be generally planned in the definition of possible times. Quality qualities emphasize that the application is scalable and functional.
c) **Design and planning phase:** This phase designs the services delivered by the application; accurately defines the times, people, equipment, and activities for the development of the computer application; deliverables design the interfaces and services of the computer application; design, creation, testing and parameterization of recognition marks; diagram classes and sequences; architecture, database, algorithms, interfaces, connections, and processes are designed; the profile and skills for the development group are defined. It must select the tools for application development. Among the qualities of quality are the functionality of the application and reusing the components in the application code.
d) **Development phase:** This phase applies the tools, standards, and frameworks adopted in the design; besides, the application is encoded and deployed; database, programming language, and framework installation; general trademark recognition; the local database on the cell phone is tested, the interfaces are verified; cloud localization services are encoded and installed; the project leader performs the control and testing, the quality control of the functionalities is applied; the flexibility of the application and portability between different mobile operating systems is verified.
e) **Delivery and closing phase:** Functional tests, unit and global tests are carried out, verification of the services that the mobile application must deliver to tourists; another quality control is applied to improve experiences; the application must be reliable and robust, easy to update through the maintenance of interfaces and services.
f) **Evaluation Phase:** Here the app is delivered to a specific group of tourists to evaluate the use, efficiency, ease, and performance of the mobile application; assessments should be used to improve functionalities and services.

Figure 1 shows the integration of quality phases, disciplines, and attributes for an environment for augmented reality development; the first phase "Pre-Analysis" and the second phase "Analysis and Requirements" are framed in *Analysis* is a discipline; the third phase "Design and Planning" is framed in *Design* is a discipline; the fourth phase "Development", the fifth phase "Delivery and Closure" is framed in *Verification* is a discipline, and the sixth phase "Evaluation" is part of *Measure* is a discipline.

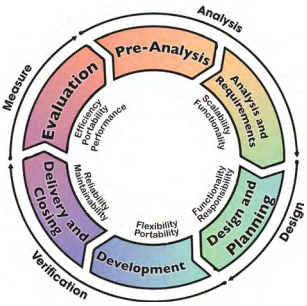


Fig. 1. Mixed methodology prototype that consolidates all six phases.

4.2 The General Algorithm of Methodology

To apply the mixed methodology proposed in this research and this is the product of the six phases, an algorithm expressed through flowchart techniques was proposed in Fig. 2; each phase proceeds according to the responses to project continuity, in the following order; (a) "Pre-Analysis" checks whether the augmented reality project in times and resources is feasible or feasible; (b) "Analysis and Requirements", specific requirements, functional and non-functional requirements, use cases are verified; (c) "Design and Planning", the application of standards in interfaces, database and services is verified; (d) "Development", compliance with the requirements is verified; (e) "Delivery and Closure", services for tourists are verified; (f) "Evaluation", feedback to improve the computer application is reviewed.

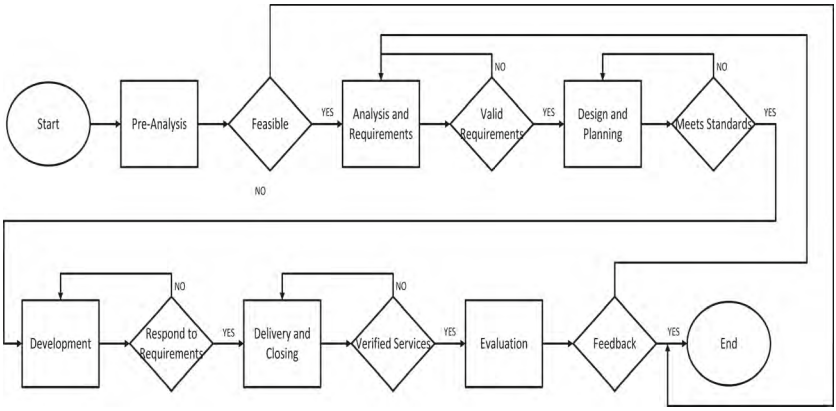


Fig. 2. The general algorithm of methodology

5 Discussion

Relationship of results: the prototype development methodology and the algorithm have a direct relationship in the execution of their phases that are framed in quality disciplines

and attributes; the result after applying the proposed methodology would be a virtual and robust tour guide application.

Generalization of results: Phases, activities, and quality were adopted to propose a methodology based on three references [3, 15] y [16]. This research does not propose templates to obtain project costs, times, human resources, technological resources, monitoring, or project control, it is not experimental, it is not a computer application, this is a theoretical proposal on a mixed methodology. This research is consistent with proposing a software development methodology with [11, 15], and [16]. The references [8, 9, 28, 29], and [30] are augmented reality computing applications in the tourism sector. As a theoretical consequence of this research, it is considered that it can serve as a guide to implement an augmented reality application; although it is necessary to improve the methodology through feedback from other researchers. Other technologies used in tourism, the movements of people, and money generated by tourism were shown, in addition to other projects that apply augmented reality, this results in the importance of applying augmented reality to tourism through a methodology proposed in this document.

6 Conclusion

A methodology proposal was made, considering the amount required in terms of functionality, data management processes, and application codes, that influence the development of computer applications. It is clear that augmented reality has great potential in many areas, tourism is a good application option for its features and benefits. Without a doubt, this theoretical proposal of mixed methodology and its application algorithm for development can be improved by other researchers through experiments and feedback.

Acknowledgments. This work has been supported by the GIIAR research group and the Universidad Politécnica Salesiana.

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Modeling and Analysis of Critical Success Factors in the Implementation of Second Life in Virtual Classrooms for Teaching in Education Using Fuzzy Cognitive Maps

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Abstract. The pandemic, produced by covid-19, gave rise to a new normal, in which education is part of that change. In certain cases, the quality of education was affected, either by factors such as deficient online teaching material, teaching issues, attention, and adaptation problems on the part of students in their online courses. To help improve performance in online education, some educational institutions have chosen to use the virtual world of Second Life to implement it in their classes, offering features that benefit learning from home, making it more didactic and enjoyable for students. The objective of this article is to find and analyze the critical success factors for the implementation of Second Life in virtual classrooms, through the construction of fuzzy cognitive maps. The use of forms aimed at students is proposed, from which the results will be evaluated and the factors that influence a quality education will be determined, building a fuzzy cognitive map for their understanding.

Keywords: Online courses · Virtual classrooms · Virtual worlds · Second life · Fuzzy cognitive maps · Critical success factors

1 Introduction

The disease caused by the coronavirus has left one of the most relevant challenges that humanity has faced due to the great impact it had in the academic field, the transition from classroom education to virtual education, around the world has caused a significant change in the way in which students and teachers learned and taught, respectively. In Ecuador, many teachers have had the opportunity to use virtual classrooms as a teaching method long before the pandemic, which is a great advantage, being able to adapt quickly and effectively to a new normal; While students who have spent practically all their student lives attending face-to-face courses experienced a radical change in the way they received these courses, which until today reflects a great impact on their quality and performance [1]. Despite the ups and downs of the new normal, education in Ecuador

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 805–813, 2022.
https://doi.org/10.1007/978-3-030-85540-6_102

has not stopped. Innovation in education is the use of virtual classrooms, which, thanks to the use of information and communication technologies (ICT), helps to develop, in a total or complementary way, the learning-teaching processes given by teachers [2]. Fuzzy Cognitive Maps (FCM) structure is used for the dynamic analysis of systems and decision-making support. These directional graphs (digraphs) present numerical values based on variables or fuzzy sets called nodes [3]. Virtual worlds are "shared and simulated spaces that are inhabited and shaped by their people, who are represented as avatars [4]. One of the most popular virtual worlds in the 2000s was Second Life (SL). The general objective of this article is to develop a model for the analysis of critical success factors (CSF) for the use of SL in virtual classrooms using FCM, to be able to demonstrate how they are used in today virtual worlds for learning in university-level students and their professional development. This study includes activities for the identification of the factors, modeling, and dynamic and static analysis that allow increasing the effectiveness in the development of this type of project.

2 Background

2.1 Fuzzy Cognitive Maps - Components

Thanks to the implementation of fuzzy cognitive maps, it is possible to represent the systems with feedback. Graphically each node is perceived as a fuzzy set, situation, or event which must be correlated with other nodes. To find the weights and correlations between the nodes, an adjacency matrix is used for its application to construct the FCM [5]. In the procedure, an input vector is set with its respective initial condition, to multiply it by the matrix derived from the diagram and thus obtain the results; by iterating the vector resulting from multiplication with the same matrix. In this way, feedback for the system is acquired. Depending on the detailed input vector, a final cycle will be reached.

2.2 Virtual Worlds

SL is a Virtual Worlds, which present a classification based on the characteristics they possess. In Table 1, the classification of Virtual Worlds according to [4] is detailed:

The continuous development of virtual worlds has allowed the visualization of a more realistic graphic quality, as well as a more frequent attraction of users to this type of technology, which makes these tools an ideal setting for teaching and research, using visual methods provided by virtual worlds, such as replaying events that cannot be simulated in real life [6]. Below in Table 2, the technical characteristics of virtual worlds according to [4] are shown.

Table 1. Classification of virtual worlds

Classification of virtual worlds	Description
Massively multiplayer online games (MMOG)	Games in which many players interact within a virtual world. The concept of MMO has spread to other types of games such as sports, real-time strategy, and others
Massively multiplayer online real-life games (MMORLG)	Known as virtual social worlds, where the user can edit and alter their avatar at will, allowing them to play a more dynamic role or multiple roles
Collaborative virtual environments (CVE)	Designed for collaborative work in a virtual environment
Multi-user Virtual Environment (MUVE)	It simulates real-life environments, users connected and communicating with each other. SL belongs to this classification

Table 2. Technical Features of virtual worlds.

Features	Description
Avatars	Virtual representations of users, which are used to interact with objects, tools, and applications of the virtual world
Multiple concurrent users	Supports the feeling of being in a shared space with other users, a virtual world must allow the simultaneous login of several users
Communication tools	Used to facilitate interactions between users, through text messages, voice chat, notifications, among others
Content creation tools	In some virtual worlds, users can create content and share it with other users in the same world
Persistence	Preservation of the location of avatars (users) and objects within the virtual world, regardless of whether users are logged in or not
Representation of space	Graphic representation of the shared space, including users and objects. This dynamic representation uses a client-server architecture

2.3 Second Life

In this virtual world, users must create an avatar that will help them interact with the world and with other users, either by communicating or socializing [7, 8]. Persistence is one of the features that most virtual worlds have, and SL is no exception since while some users log-off, others are actively interacting with the world, transforming it, and making it grow, all these changes they remain, that is, they persist because it is a space in which the activity does not cease for a long time [9]. Other outstanding features that SL possesses are detailed below in Table 3.

Table 3. Outstanding features of second life.

Features	Description
Teaching processes	Offer courses within SL, an opportunity that high-level institutions such as Harvard, Stanford, among others have used
Trading	Products and services for avatars, such as clothing, digital travel
	Make online shopping and receive them in the real world
	The money they use, Linden dollar, can be bought or sold on various redemption websites where their respective currency conversion takes place
Job	Every user can work giving a service or product in SL

The construction of a classroom and direct interaction with students and teachers makes it a potential opportunity to generate a more attractive, technological, and innovative learning environment [10]. As well as its potential advantages, it also presents disadvantages, which are shown in Table 4.

Table 4. Advantages and disadvantages of using second life for teaching.

Advantages	Disadvantages
It offers various information formats (multimedia text, etc.)	The annual or monthly rental cost of islands used for the construction and maintenance of all types of establishments
It favors participatory behavior	It is not recommended for large educational projects
The student becomes more active by having to manage his character, supporting the teacher's didactics	Its main objective is not educational, as it is on platforms like Google Classroom
The use of 3D images offers more immersive learning	It is not possible to perceive the body language to be able to detect problems of the student
Have various perspectives of objects in the world when moving in the world	Teachers may require extensive initial training
Open content: every user has access to them	Dozens of controls and settings can make learning difficult

3 Materials and Methods

The CSF model is designed based on being able to define and guarantee the use of SL as a learning tool. With the proposed model, the objectives to be achieved will be taken to demonstrate the efficiency of virtual worlds and their CSFs based on those set out in

Table 5. The type of use in teaching will be considered, whether they are theoretical or practical subjects where your application is promising.

Table 5. Critical Factors of Success.

	Factors	Description
Z1	Improve teaching efficiency	Assists students to gain greater knowledge in the designated area of study
Z2	Get better academic performance	Improves the performance of students with learning disabilities or concentration problems more practically and dynamically
Z3	Increase technical skills	It improves the skills of students who need practice in academic subjects
Z4	Optimize compression capacity	Improves understanding of the most difficult subjects to help students understand them
Z5	Get more professional practice	By getting better practice in the study area

The input of information will allow feeding the processing model where experts in the process will intervene, processing that will help with the creation of relationships, then a static analysis will be carried out and will end with a simulation of the scenario to predict the future behavior of the CSFs that will allow the creation of the FCM and its relationships; and finally, the information output will return the organized and structured data that will represent the deductions made by the information processing model [3, 5]. The use of the CSF (Table 5) allows taking important points as a reference to the advantages of using SL to develop the matrix of adjacency that will allow the construction of the FCM model.

3.1 Case Study

According to previous studies in SL, virtual islands were created to apply the teaching operation in virtual courses either through a virtual classroom or a workstation that allows interaction with the group of students and the teacher [11]. Taking into account the mechanics of SL allows the simulation of an environment that helping students who occupy subjects to carry out a practical activity either construction or experiments where students need the materials to be able to practice without having the consequence of suffering any physical or environmental damage [11–13].

Through FCM, it will be possible to observe the efficiency of the use of SL as a learning tool, verifying the inputs, processes, and outputs of information collected by previous studies [14]. With the information obtained previously, the nodes of the FCM will be determined with the information of the CSFs.

3.2 Construction of the MCD

For the study, the construction of an FCM was carried out taking the data of the CSF (Table 6), by collecting data obtained by collecting information from scientific articles

[15], the values of the concept (P) are acquired using the analyzed values to later be classified in an interval [0, 1], in the same way, the accidental arcs take values acquired by an interval [−1, 1] for their development.

Table 6. Domain of values to express causality.

Value	Impact
−1	Negatively Very Strong (NVS)
−0.75	Negatively Strong (NS)
−0.5	Negatively Medium (NM)
−0.25	Negatively Weak (NW)
0	Without Importance
0.25	Positively Weak (PW)
0.50	Positively Medium (PM)
0.75	Positively Strong (PS)
1	Positively Very Strong (PVS)

To calculate the values of the inputs, they are obtained through the advantages of previous studies and they are calculated using the values to express causality in Table 6, the relationships are determined, then the weight and sign of these relationships can be obtained, the values will be placed of knowledge for the construction of the FCM where a sample of experts (k) will be applied, and the adjacency matrix will be obtained thanks to the formula that is expressed in the following equation:

$$A = \frac{1}{k}(A_1 + A_2 + \cdots + A_k)$$

Then the knowledge is added that will allow to refine, fix, and optimize the reliability of the final model, which is less likely to contain errors, and this will allow them to verify the functionality of the adjacency matrix.

4 Results

The analysis of the case study allowed to determine the behavior of the different and possible results in the use of SL in teaching. An example was used in its use for teaching with values obtained through an informal survey.

4.1 Evaluation Criteria

The process was carried out by selecting the evaluation criteria focused on the learning area for young university students of different areas, etc. [11, 12, 16]. The proposed CSFs were used to be able to select and compile information on SL focused on learning,

in Table 5 those points were the most used because in previous studies proposed as advantages of SL, and its use in the learning also allowed to verify a better analysis in the resulting matrix Table 7. Likewise, the relationships between the criteria help us determine what are the relationships between the nodes proposed in Table 5, where the design of the adjacency matrix will be obtained together with their relationships and using its adjacent matrix obtained as a result of the critical success factors process [14].

Table 7. Resulting adjacency matrix

	Z1	Z2	Z3	Z4	Z5
Z1	0	1	1	1	1
Z2	−1	0	0	1	1
Z3	0	−1	0	0	1
Z4	1	1	1	0	0
Z5	−1	−1	1	0	0

4.2 Obtaining the FCM

The general FCM is expressed using a graph nourished by the information obtained from the information of previous studies compiled by scientific articles related to SL in the teaching of virtual classrooms, where the information is obtained by an adjacency matrix that allows the relationship between the nodes that would allow the creation of the FCM Fig. 1 [15].

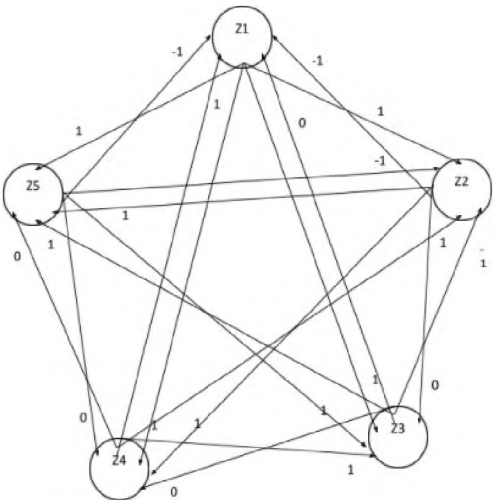


Fig. 1. FCM obtained by the adjacent matrix.

4.3 Evaluation

It is observed how the Z1 has a positively greater relationship with all the relationships of the CSFs. The process received input information, the results obtained by the FCM where the evaluators allowed to be classified on a numerical scale allowing to obtain a better result to analyze the advantages of SL and be able to implement it in universities to help students in learning and improve their practical activities, which are applied in the work area and that do not present deficit in that area to reduce work errors [15].

5 Conclusion

It is concluded that the most significant factor in the case study is to improve the efficiency of teaching since it positively influences the other factors and does not negatively affect them. This will allow in the future to use SL to help students of different educational levels in their subjects given online thanks to the advantages provided by this software, helping to have a more immersive, participatory, and collaborative experience, which would lead to an improvement in the cognitive abilities of students, allowing a more realistic and stimulating interaction to want to learn more about its users to take advantage and discover many more possibilities of its implementation in the academic field. Concluding the study, it was possible to demonstrate the efficiency of SL as a more reliable tool for studies and contributes to the development of more competent professionals.

Acknowledgments. This work has been supported by the GIIAR research group and the Universidad Politécnica Salesiana.

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Machine Learning and Digital Twin for Production Line Simulation: A Real Use Case

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Abstract. The advent of Industry 4.0 has boosted the usage of innovative technologies to promote the digital transformation of manufacturing realities, especially exploiting the possibilities offered by cyber physical systems and virtual environments (VEs). Digital Twins (DTs) have been widely adopted to virtually reproduce the physical world for training activities and simulations, and today they can also leverage on the integration of Machine Learning (ML), which is considered a relevant technology for industry 4.0. This paper investigates the usage of a combination of DT and ML technologies in the context of a real production environment, specifically on the creation of a DT enhanced with YOLO (You only look once), a state-of-the-art, real-time object detection algorithm. The ML system has been trained with synthetic data automatically generated and labelled and its performance enables its usage in the VE for real-time users training.

Keywords: Machine Learning · Digital Twin · Virtual reality · Industry 4.0 · Virtual manufacturing · Synthetic dataset

1 Introduction

The advent of the Fourth Industrial Revolution has boosted the usage of innovative technologies to promote the digital transformation of manufacturing realities, improving the automation of traditional industrial practices and processes. Nowadays, factories should leverage digitalization to become flexible towards strong products customization and adaptive to unexpected events.

Among these relevant technologies, Digital Twins (DTs) have been widely adopted to virtually reproduce the physical world and to integrate real environments with their digital counterpart [1]. DTs can enhance manufacturing systems in many ways: they can be used to improve the system's predictions of future states by combining simulation models and real data; their simulations can support decision-making tasks, process optimization and commissioning of production operations; a virtual simulation with a

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 814–821, 2022.
https://doi.org/10.1007/978-3-030-85540-6_103

precise reproduction of a real-world process would improve remote assistance, could be adopted to train technicians, and could be exploited for maintenance procedures.

Machine Learning (ML) is another crucial technology to improve the automation of manufacturing systems: it can extract useful insights through a training process on large volume datasets and then exploit the acquired knowledge in real case situations [2]. A relevant challenge in the training process is the availability of huge, labelled datasets consisting of high-quality data. To overcome this challenge, simulation tools could be exploited to automatically generate large datasets of quality data for training ML models, both in a cost and time-effective way, alleviating the need for real world data. Nowadays, digital simulations which integrate ML mechanism based on synthetic data have not been widely researched and a few papers explore this scenario. This contribution describes the development and deployment of a DT of a production line for assembling skateboards. The physical line has been deployed at the Competence Industry Manufacturing 4.0 (CIM 4.0) Center, a research center located in Turin which aims to provide the strategic and operative support tools for manufacturing-oriented enterprises toward the digital transformation of industrial processes accordingly to the Industry 4.0 vision. The production line exploits an image-processing algorithm to assist a collaborative robot (cobot) in a pick and place task. Since this step of the procedure relies on an obsolete contour detection image processing algorithm, it turned out to be prone to errors. The DT is then exploited to simulate and evaluate a novel image-processing approach based on a convolutional neural network (CNN) trained with a synthetic dataset which can provide real-time performances, thus enabling the DT to be used for real-time immersive virtual reality simulations.

The remaining of this paper is organized as follows: Sect. 2 explores the state of the art for the proposed research topic. Section 3 provides a detailed description of the design and development of the proposed Digital Twin. Section 4 illustrates the system evaluations, with a focus on the CNN performance assessment. Section 5 summarizes the paper contents and suggests possible future works.

2 Previous Works

Recent advancements in information technologies have been proven to have wide applications in smart manufacturing [4]. The adoption of artificial intelligence, enhanced algorithms and virtualization of production lines in manufacturing-oriented enterprises can lead to real-time, self-organized control and coordination of the industrial process through digitization and simulations [5]. DTs have been exploited in many ways to enforce the innovation process defined through the Industry 4.0 paradigm. Nikolakis et al. [6] proposed a DT framework to optimize the planning and commissioning of production process through simulation. Tao et al. [1] reported several DT applications which have been successfully applied in manufacturing processes to reduce costs and to improve performance. ML has been exploited as well as DTs to improve manufacturing processes. CNNs, whose main purpose consists of image processing and analysis, have been widely adopted in industry for: automatic defect identification [7], system optimizations [8], product diagnostics [9], classification tasks [10], and for part detection and recognition in robotic manipulation tasks [11]. Moreover, advances in computer

graphics are shifting the dataset creation paradigm for training ML models towards synthetic datasets: Gaidon et al. [12] generated a photo-realistic dataset of virtual environments for transport. Dekhtiar et al. [13] used CAD datasets to train a deep neural network for mechanical component recognition in industrial environments. Dahmen et al. [14] proposed a synthetic dataset to perform defect detection in optical inspection systems. Alexopoulos et al. [3] proposed a framework for implementing DT models for training ML models. However, they also highlight the lack of concrete implementations of real use cases investigating the validity of DT-driven ML systems. The topic of generating synthetic datasets from DTs is not widely discussed in literature, especially in association with manufacturing systems.

3 System Design and Development

The aim of this work is to create a DT of a demonstrative Industry 4.0 production line for assembling skateboards. The purpose of the DT is manifold, since it will be used to 1) visualize, navigate and inspect the production line through immersive Virtual Reality (VR), 2) train technicians to correctly interact and operate the different technologies and their interaction interfaces and 3) test and evaluate possible upgrades to the physical line in a VE prior to implementing them in the real world. The line process consists of four macro steps: 1) the technician starts the process selecting through a user interface the color for the wheels, the trucks, and the board; 2) then he/she picks the components from an automatic warehouse and positions them on the production pallet; 3) a robotic manipulator performs a pick and place task to assemble the skateboard; 4) the technician completes the skateboard assembly fastening all the screws in the last step.

3.1 The Physical Production Line

The physical production line consists of three main assets which are shown in Fig. 1: 1) a Modular Intralogistic Organizer (MIO) by Comau, which operates as an automated warehouse, 2) a Virtual Guidance Interactive Learning (Vir.GIL) system by Comau, a complex system which combines together different technologies to provide digital guidance to the user, and 3) a Racer 5 by Comau, a 6-axis articulated robotic manipulator with a 5 kg payload, designed to ensure both industrial efficiency while providing safe, barrier-free operations.

The MIO rotates its eight shelves providing, one at a time, all the parts required to assemble the skateboard. The Vir.GIL system guides the operator through the preparation of the production pallet: a laser pointer and vocal hints suggest where and how to correctly place the components. For the third step of the procedure, the pallet is manually moved by the operator from the Vir.GIL workbench to the Racer 5, which starts picking each component and assembling the skateboard. Since the position of the wheels is not fixed and the cobot needs to detect their precise locations to correctly pick them up, an image processing algorithm tries to detect their position searching a circular shape in a given frame of the pallet. Then, if the precision is higher than 80%, the system is confident on the wheel position and proceeds with the pick and place operations. Finally, the operator moves back the pallet to the Vir.GIL station to fasten the screws.

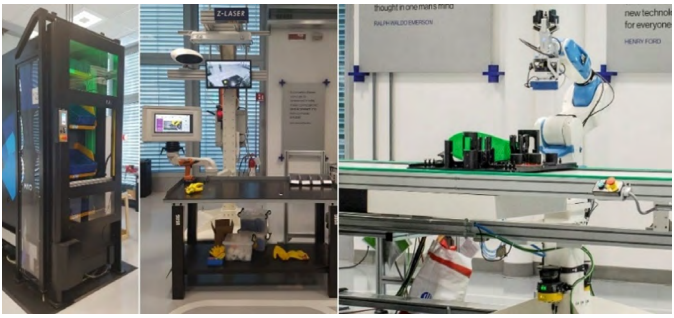


Fig. 1. The MIO (left), the Vir.GIL (center), and the Racer 5 (right).

3.2 The System Architecture

The proposed DT was developed and deployed on a workstation equipped with an Intel Core i7 CPU, an NVIDIA GeForce Quadro 4000 Graphic Card and 128 GB RAM with dual boot for either Windows 10 or Ubuntu 20.04 LTS. The DT was developed in Unity 3D on Windows: the SteamVR plugin enables the application to run on the HTC VIVE Pro (2018) immersive Virtual Reality headset, whereas the Barracuda plugin is used to integrate the neural network, exported in the Open Neural Network Exchange (ONNX) format, into Unity 3D. The ML system was deployed on Ubuntu using Darknet, an open-source neural network framework written in C and CUDA. The Darknet framework was deployed to use You Only Look Once (YOLO), a state-of-the-art, real-time object detection system, to recognize the pose of the wheels for the pick and place task. To this end, it was necessary to install the NVIDIA Cuda Toolkit, the Cuda Deep Neural Network library and the OpenCV library. The synthetic dataset used to train the Neural Network was generated through Blender, an open-source 3D modeling software. Unity 3D is a state-of-the-art game engine, widely used due to its cross-platform capabilities and its compatibility with novel technologies such as the HTC VIVE. Since the purpose of the DT is the training of an operator, Unity 3D provides a simple and intuitive framework for creating a complex VR interactive experience.

3.3 Digital Twin Development

The DT was developed retrieving the 3D models for all the physical assets and objects of the production line. The wheels, board, trucks, and screws of the skateboard have been modelled in Blender. The main goal of the DT is to offer an interactive experience; thus, it was necessary to recreate all the interactions and actions available in the real environment. The DT enables the user to navigate the virtual space, to grab the skateboard components and the pallet, and to operate the Racer 5, the MIO and the Vir.GIL. The MIO and the Racer 5 cobot behaviors have been virtualized through a combination of scripting and custom animations created in Blender. The vocal hints provided by the Vir.GIL were translated into visual hints in the form of 2D pop up displaying the instructions and bouncing 3D arrows to highlight the points of interest on the workbench. A snapshot of the final DT is shown in Fig. 2.

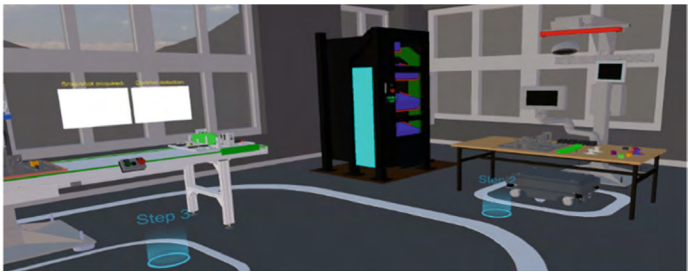


Fig. 2. A snapshot of the final digital twin production line.

3.4 Object Detection Through Real-Time CNN

The third step of the process involves the pick and place task performed by the Racer 5. The current vision system tries to detect the wheels position searching their shape in the framed image. However, the system cannot distinguish between face up and face down wheels, thus, when the pallet is placed under the cobot the wheels may be on the wrong side. To improve the pick and place task and make it robust to this type of errors, YOLO has been deployed to correctly detect the wheels. YOLO has been proven to be extremely fast and accurate [15] and it allows to easily tradeoff between speed and accuracy simply by changing the size of the model, without retraining the whole neural network. After deploying YOLO, the synthetic dataset used for this research was generated with Blender, using the wheel digital model created for the DT. A python script has been developed to automatically produce high-quality renders exploiting Blender's Eevee render engine. YOLO should be able to recognize 3 classes: wheel top, wheel back and wheel side. Thus, the script created 150 renders for each class, for a total of 450 images with resolution 960 × 540 pixels (as depicted in Fig. 3). To make the detection system more reliable and flexible, variations have been introduced for each class in term of colors and camera perspective. For each render the script annotates (within a .txt file) the label for the class, the x-axis and y-axis coordinates, the width and height for each object.



Fig. 3. Samples of the training dataset (left) and of the validation dataset (right).

To start the training phase, it is necessary to setup the configuration file, where it is possible to define the number of classes (3), epochs (6000), filters (24) and the size of the images taken as input (416 × 416 pixels). Those parameters have been fine-tuned through numerous tests on the specific dataset to achieve optimal performances. The input size is different from that of the synthetic dataset because the original renders are

modified in the data augmentation step performed by the proposed detection system, which enlarges the training dataset by a large number of variations obtained through cropping, scaling and other visual artifacts and transformations applied to the original images. A validation dataset is defined to compute the mean Average Precision (mAP) of the neural network (two samples are depicted in Fig. 3). The training process is started through a shell prompt, and it takes about twelve hours to complete. Once the training phase was completed, the model was tested with both images and a video of the real production line. The YOLO system grabs each frame of the video, makes the prediction, and shows the result as a new, labelled video. To use the trained neural network in the DT Unity 3D application it was necessary to convert it to the Open Neural Network Exchange (ONNX) standard, an open format for ML models which allows to easily interchange models between various ML frameworks and tools. Through the ONNX, the DT can perform the object detection on a snapshot of the wheels taken with an invisible camera in the VE, at the same position and perspective of the real one. The result of the detection will be a tensor, a container that stores data in N-dimensions. The trained YOLO system generates an output of dimension $24 \times 52 \times 52$ containing the results of the detection, given by the bounding boxes and the confidence of the detection. For each object detected in the input image, the output tensor stores the x-axis coordinate, the y-axis coordinate, width, and height. After filtering these results by selecting the ones with higher confidence, it is possible to draw the corresponding bounding boxes to the snapshot used as input, using different colors to distinguish the three classes (top, back, side). Figure 4 shows an example of real-time detection.

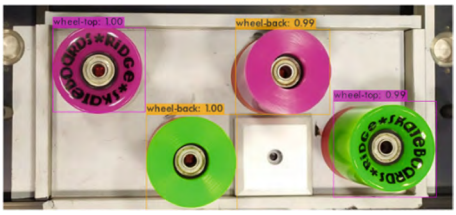


Fig. 4. An example of real-time detection on the real pallet.

Inside the VE, a GUI panel displayed near the cobot shows at each frame both the acquired snapshot and the detection result, whereas the user can restart the detection by a button (e.g., after correcting the pose of a misplaced wheel). The ONNX module is able to run YOLO and give back the results in about 2 s, which is a reasonable delay for testing the behavior of the cobot inside the DT.

4 System Evaluation

Due to the Covid-19 Pandemic, it was not possible to statistically evaluate the DT system by end user tests. However, the DT has been tried by both researchers and technicians from the CIM 4.0 competence center and has been assessed through interviews as a proper and complete digitalization of the physical production line.

Moreover, the YOLO detection system allowed to test an enhancement of the physical line, overcoming a limitation of the real model. In regards of the YOLO object detection system, the accuracy has been estimated by calculating the mAP during the training phase. The mAP compares the ground-truth bounding box to the detected box and returns a score. The higher the score, the more accurate the model is in its detection. For this purpose, a validation dataset of 55 images (labelled using YOLO mark) taken from the real world has been defined. Every 4 epochs of the training phase the AP is being calculated using images from the validation dataset. Figure 5 shows the loss function in blue and the mAP trend in red. The loss function is very high at the beginning, but it rapidly decreases as the model learns how to detect the wheels. The mAP increases during the epochs, and it reaches its maximum value nearby the 2400th epoch. The validation dataset and the corresponding trend of mAP are useful to select meaningful parameters for the detection system configuration. In this case, the mAP indicates that the best weights are around the 3000th step of the training phase. Testing the model in the real environment, with the weights obtained in the dataset validation step and the input from an industrial camera, proved that the system can achieve an accuracy of 85%.

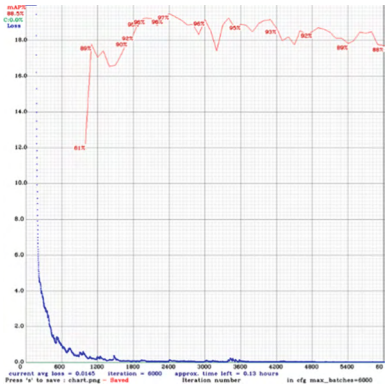


Fig. 5. Average Precision (red line) and loss function (blue line).

5 Conclusions and Future Works

The proposed research describes the development and deployment of a Digital Twin of a production line for assembling skateboards, which combines different recent technologies and image-processing algorithms, especially to assist a cobot in a pick and place task. Since this step of the procedure relies on a detection approach prone to errors, the DT was exploited to simulate and evaluate a possible upgrade for the production line. To overcome this limitation, the DT integrates YOLO, a state-of-the-art, object detection system based on a CNN trained on synthetic data, which provides real-time performances for real-time immersive VR simulations. Overall, all the technologies provided in the physical line have been successfully digitalized in the DT, resulting in a compelling and valuable tool that will be used to visualize, navigate and inspect the

production line through immersive VR and to train technicians. The proposed upgrade to the image-processing system clearly enhances the system reliability and will lead to a physical update of the real-world system. Future works will be aimed at further testing and evaluating upgrades to the physical line in the VE prior to deploying them in the real world.

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Human-Robot-Interaction via AR: First Steps of Building a Human-Robot Interface on a Microsoft HoloLens

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Abstract. Augmented reality is a concept for extending reality with additional information, which is basically not limited to visual representation, but is mostly an essential component. Here, we developed an augmented reality (AR)-based human-machine interface to run an industry robot. A Microsoft HoloLens with spatial mapping was used in an AR environment to operate a full-size virtual industry robot with bare hands, using the natural operation behaviors without additional handheld devices. Communication between HoloLens and the real industry robot was achieved by using the Mitsubishi-owned R3-protocol. The precise and timely transmission of instructions from the HoloLens to the industry robot via the Mitsubishi-owned R3-protocol provides a suitable template for future AR-based research and development in the field of engineering.

Keywords: Augmented reality · HoloLens · Industry robot · Human Machine Interface (HMI) · IIoT · OPC UA · TCP/IP · Digital twin

1 Introduction

As many other research labs [1–3] the Otto Rettenmaier-research laboratory (Otto Rettenmaier-Forschungslabor/ORFL) at Heilbronn University of Applied Sciences owns a model factory. Part of the model factory is a module with an industrial robot as shown in Fig. 1 which is in use to test an augmented reality human-robot interface. As shown in [4] augmented reality provides a good usability for robotic applications, so this paper describes a research project focusing on the interaction with the above-mentioned robot via the use of an augmented reality device represented by a Microsoft HoloLense.

1.1 Augmented Reality (AR)

The concept of Augmented Reality was first described by Milgram and Kishino (1994) and comprises four systems: (I) real environment, (II) augmented reality (AR), (III) augmented virtuality, and (IV) virtual environment. The purpose of AR is to allow users

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 822–829, 2022.
https://doi.org/10.1007/978-3-030-85540-6_104

to control and operate real objects in a real environment by creating an operating interface in a virtual environment [5].

Thus, AR technology needs to combine a geospatial data for the virtual object, a surface to project virtual elements to the user, and an adequate processing power for animations. In contrast to virtual reality that allows only regulation via signal conditioning device or through voice command, AR permits the user to operate the robot via gesture [6].

With the increasing digitalization of factories, it is essential that employees become part of the digital factory so that they are not seen as a foreign body in the ecosystem. With this transformation, the employee can call up production parameters from any location at any time and thus prevent downtimes on the production line [7].

In the underlying work, it was shown that the use of augmented reality data glasses makes it possible to operate any industrial robot with manual guidance, even if this was implemented using a robot from Mitsubishi Electric as an example.

2 Laboratory Equipmet

2.1 Industrial Robot

The industrial robot is a 6-axis robot from Mitsubishi Electric, which is integrated in the Festo didactic system. It is connected to an WLAN bridge via an Ethernet cable. The WLAN bridge is later used to communicate with an AR device, either via the 2.5 GHz or 5 GHz WLAN radio network.



Fig. 1. Mitsubishi RV-2FB-D1-S15

2.2 HoloLens

The Microsoft HoloLens is an augmented reality device that combines the entire computing unit in itself and thus does not represent a peripheral device for a computer.

As shown in Fig. 2 the first generation HoloLens is equipped with various sensors [6]:

- 1× Inertial Measurement Unit (IMU)
- 4× environmental cameras (1)
- 1× depth camera (2)
- 1× 2-megapixel photo/HD video camera (3)
- 4× microphones
- 1× ambient light sensor (4)
- 4× IR emitter (5)

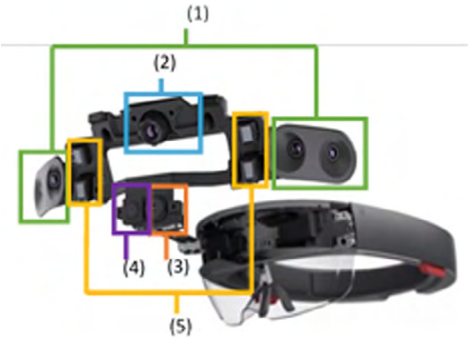


Fig. 2. Assembly of the first generation HoloLens

HoloLens uses the time-of-flight (TOF) method to perceive its surroundings. The depth camera measures the time of the impulse reflection and creates a three-dimensional image of the environment from the information gained. The process is also called Spatial Mapping by Microsoft. The projectors make use of the physical effect of total reflection, which means that a light beam is completely reflected at a certain angle within the medium when it enters. The light beams are reflected back and forth until they reach the exit angle of the reflectors and are projected directly into the human eye. Microsoft speaks of 2,500 light points/RAD but does not specify whether this is the number of light points on a horizonal or vertical line or even a surface. It can be said with certainty that holograms in the vicinity have a higher resolution than those that are further away [8].

2.3 Workbench

Unity 2017 was used to develop the application, as well as Visual Studio 2019 Enter-prise to create C# scripts. The user interface was created in Unity.

2.4 Communication Between the Robot and the HoloLens

Communication takes place via the TCP/IP interface. The communication is based on Mitsubishi's own R3 protocol, which is understood by all industrial robots from Mitsubishi Electric. Unfortunately, it has been shown that the current communication via OPC-UA is unsuitable for this application, the problem being the low communication exchange rate and the increased delay time.

The structure of the complete message can be seen in Fig. 3. It is to be noted that under Rbt.ID both the robot number and the program location number are summarized [9].

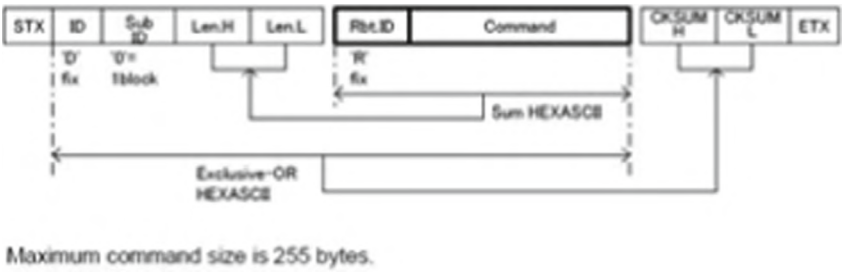


Fig. 3. Message structure of the R3 protocol [9]

As shown in Fig. 4 the PC in our use case the HoloLens sends a communication request to the Mitsubishi controller. If the controller is ready for further information, it sends back an ACK (acknowledge). A special feature here is that if the controller is not ready, it sends a NAK (not acknowledge) [9].

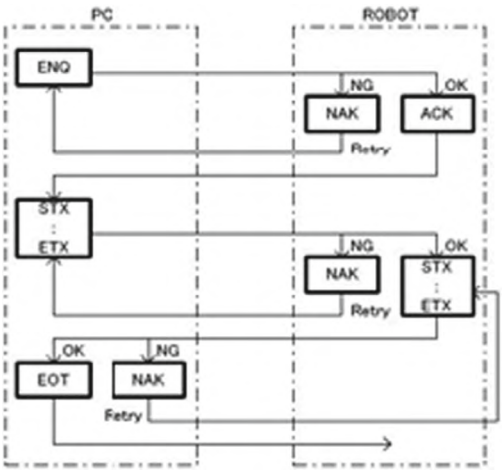


Fig. 4. R3 protocol communication flowchart [9]

Only then the actual message is transmitted and checked for completeness and, if necessary, an ACK or NAK is sent. If no irregularity is detected, an EOT is transmitted [9].

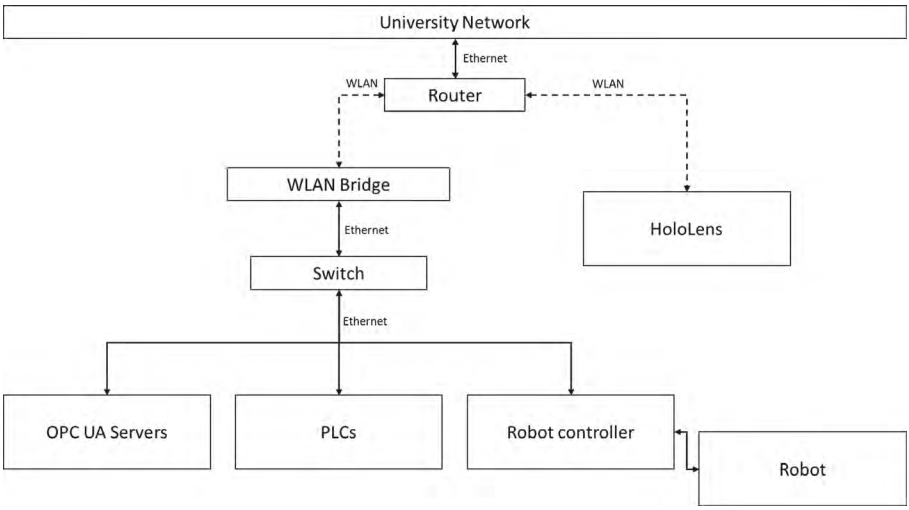


Fig. 5. Network structure in Laboratory

Figure 5 shows a section of the laboratory network. Here, the Siemens PLC acts as a safety PLC and monitors the robot to ensure that no unauthorized movements are performed. Because of this structure, we are already getting a more significant delay in accepting and executing the commands sent and processing the responses, as opposed to the hand-held control unit connected directly to the robot controller or other control units that simply send signals within the Ethernet network in the Festo plant.

3 AR Human Machine Interface and Industry Robot

The HoloLens enables new operating concepts that can bring some advantages other than the classic concepts. It has also been shown that a simple reproduction of the original operating concept is not suitable, as no major advantages are generated here. With the newer version of the HoloLens, it is possible to create a virtual image of the industrial robot and to store the inverse kinematics for this model. This means that it is now possible to grasp the virtual robot at the TCP and pull it to the desired position. As long as the calculated inverse kinematics match that of the real robot exactly, the motion should correspond exactly to the real robot. For this purpose, the disclosure of the inverse kinematics by the manufacturers of the robot would be important (Fig. 6).

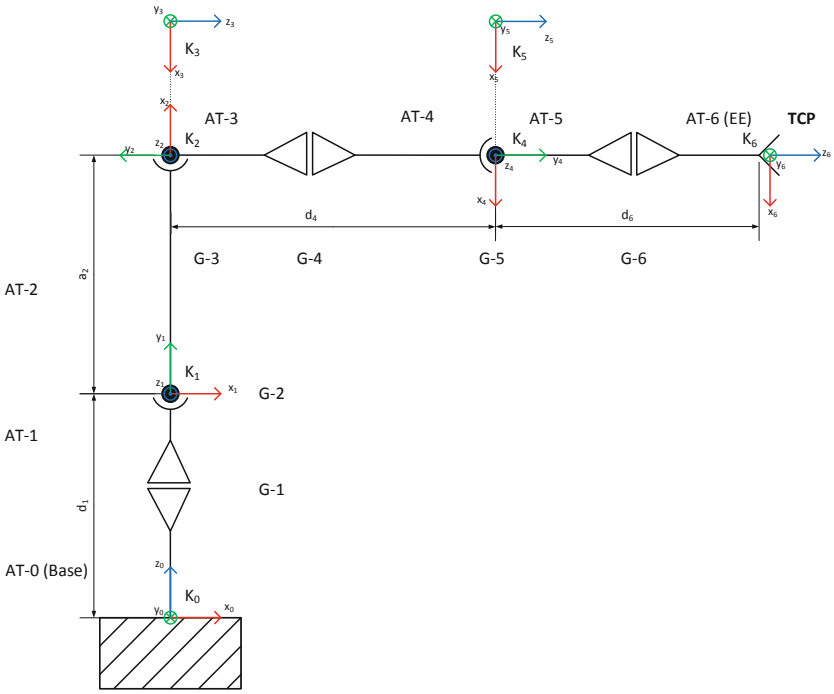


Fig. 6. Symbol representation of a RV6

The Denavit Hartenberg parameters, which are listed in the Table 1 below, were taken from the CAD model and should therefore not differ from the real robot.

Table 1. Denavit hartenberg parameters of the RV6.

Axles	θ	d	a	α
1	0°	$d_1 = 0,295$ m	0	90°
2	90°	0	$a_2 = 0,278$ m	0°
3	180°	0	0	−90°
4	0°	$d_4 = 0,270$ m	0	90°
5	0°	0	0	−90°
6	*0°*	$d_6 = 0,070$ m	0	0°

This allows the TCP coordinates to be manipulated, similar to what is already done with special robots that support hand guidance and are mostly cobots. The possibility to do this also with normal industrial robots should not only save time, but also increase the accuracy of teaching the points.

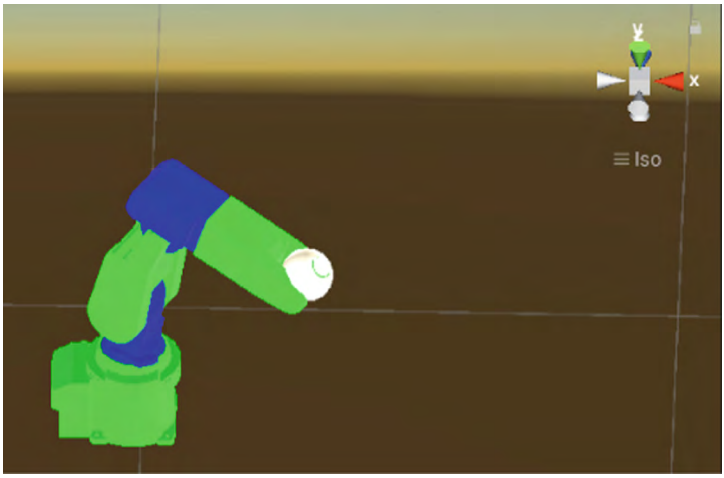


Fig. 7. Augmented reality user interface

In Fig. 7 the digital twin in the Unity environment and activated hand guide mode are shown. This is recognizable by the white ball on the TCP (Tool Center Point), which can be used to manipulate the coordinates of the TCP.

If entire production lines are available as a virtual image and an AR interface is available, errors can be corrected more quickly because the employee can perceive the error diagnosis directly in his field of vision, regardless of where he is located, and receives step-by-step instructions for solving the problem.

Voice control increases the convenience of accessing certain resources. The extent to which voice control can be used in real production still needs to be clarified.

4 Outlook and Discussion

The HoloLens enables many innovations that allow meaningful operation and added value to the processing of the data. However, it is essential that the manufacturers disclose the inverse kinematics of the robots so that a meaningful integration of the digital twin into a virtual production line can take place in the future.

IIoT will continue to reform production lines. Away from individual displays that provide information on the respective sub-plant - to AR displays that the plant's employees will wear in order to read all values conveniently and to merge with the digital factory. This new symbiosis between people, products and factories will increase quality, reduce production downtime and at the same time reduce operating costs.

Virtual reality can reduce the development costs of new production plants and realize a faster commissioning of the plant. However, VR applications are more unsuitable for running operations, as the simulations cannot be overlaid in the real world. This is where augmented reality can apply points, as it can project the individual steps into the field of view during troubleshooting. Another important aspect that speaks for the AR application is the higher safety when teaching and moving the robot, since the environment itself can be observed and thus critical situations can be avoided better [10].

AR holds great hope for improving student learning. In AR research, its most important function is its unique ability to create an immersive mixed-reality environment that blends digital and physical objects, thereby fostering process skills such as critical thinking, problem solving, and communication through interdependent collaborative exercises [11].

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Human-Machine Interaction: Controlling of a Factory with an Augmented Reality Device

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Abstract. This paper describes an implementation of an augmented reality user interface for a model factory. The focus here is that the user interfaces are exactly where the user expects them to be, be it directly on the devices or that they follow the user.

Keywords: Augmented reality · Microsoft HoloLens · Industry 4.0 · IIoT · OPC UA · Model factory · Human-machine interface

1 Introduction

The Faculty of Mechanics and Electronics of the Heilbronn University of Applied Sciences owns, as many other many research labs [1–3], a model factory for educational and research purposes [4]. The model factory is one of the five major parts of the Otto Rettenmaier-research laboratory (Otto Rettenmaier-Forschungslabor/ORFL) in which different engineering disciplines do their research. As shown on Fig. 1 the model factory which is a laboratory size contains several modules for filling up little bottles with liquid or solid substance-es. After filling, the bottles are packed up in trays and transported to a robot. This robot empties the bottles so that the bottles are fed into the process again.

The main research focus on the model factory is human-machine interaction and usability optimization based on augmented reality. In [5] the base for controlling such a factory with an augmented reality device was set. It describes how an augmented reality device, in this example a Microsoft HoloLens, can be connected to a factory via OPC UA and how an augmented reality user interface can look for such a factory. Beside human machine-interaction the model factory is also used for research items focused on artificial intelligence and communication topics. In the future, these two research branches of the ORFL will be joined at the model factory.

As shown in [6] augmented reality provides a good usability for factories, so this paper describes a research project focusing on the interaction with the above-mentioned factory via the use of an augmented reality device represented by a Microsoft HoloLens. The Particular attention was paid to the development and the implementation of the visual interface in the field of view of the user and the integration of operation via hand

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 830–836, 2022.
https://doi.org/10.1007/978-3-030-85540-6_105

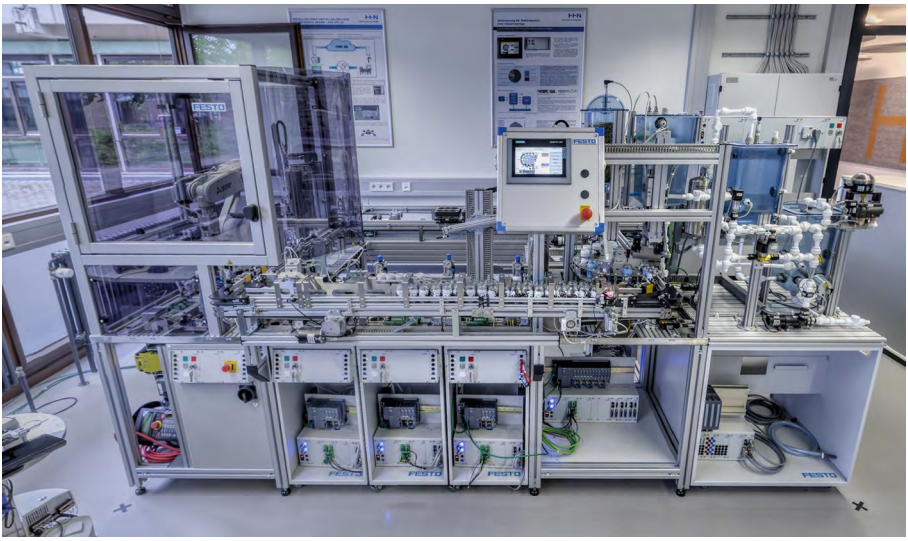


Fig. 1. The model factory in the ORFL

gestures. The interaction with the factory is realized with a control panel shown by the augmented reality device that has similar functions as a typical industrial panel with touch interaction. Button menus have been implemented for typical factory operations. When elements are selected, visual feedback is achieved by enlarging the selected element and by highlighting it in color. The actual click is additionally represented by an acoustic signal.

The control panel is following the user around the factory on the right side of his field of view. When the point of view changes the panel is following with a little inertia. With a faster turn of the user's head to the right he can reach the panel with the curser of the augmented reality device. As soon as the curser hits the panel, it holds its position in space. When the curser leaves the control panel it moves back to its position in relation to the user to the right side of his field of view. It is also possible to fix the position of the control panel in space therefore it is not following the user anymore.

In addition to the control panel on the right side there is a dashboard on the left side of the user's field of view. The idea behind the dashboard is to add selected sensor displays to a dashboard panel that can be moved and fixed independently of the main control panel.

2 Augmented Reality Utilization Concept of the Model Factory

The augmented reality utilization concept of the model factory is based on four main functions. The Curser, the user interfaces of the modules of the factory and, as mentioned in the introduction the control panel and the dashboard.

2.1 The Cursor

The cursor gives the user the possibility to interact with other interactive elements of the user interface. It is implemented in such a way that it imitates the familiar behavior of a mouse pointer on PCs and can be recognized as a cursor immediately and without the need for instruction due to its optical representation.

The curser is always in the center of the field of view. It is represented as a white lens-shaped object that hugs the surfaces of the underlying 3D model. The underlying 3D model is either a representation of reality which is created by the HoloLens using spatial mapping or an object that augments the reality. The cursor always lies flat on the respective surface of the 3D model. The size of the cursor changes depending on the distance between the viewed surface and the user itself. These properties ensure that the operator can clearly and unambiguously identify on which virtual or real object the cursor is currently located.

As already mentioned in the current implementation, the cursor is always in the center of the field of view. It cannot be hidden by other real or virtual elements and is therefore always in the operator's field of view. To move the cursor, the operator must change the field of view by moving the head.

Interactive elements exist within the user interface, some of which are described in more detail below. If the cursor is on a surface of an interactive element, the operator can perform an action by a defined hand gesture. This action imitates a click of the left mouse button on a normal PC. To tell the operator that the cursor is on an interactive element, the cursor sends visual feedback by a subtle color change. When clicking or executing the hand gesture, the operator again receives visual feedback as well as acoustic feedback.

With the help of the imitation of known behavior of a PC cursor as well as optical and acoustic feedback, an intuitive and comfortable operation of the cursor by the operator is created.

2.2 The User Interfaces of the Modules

The user interfaces of the modules of the model factory are mainly designed in such a way that transparent collider boxes are placed over real assemblies that should have the possibility to interact with. These collider boxes are interactive components and can be clicked on. The elements that are interactive show a tap symbol as shown in Fig. 2. This serves as a hint to the user that the assembly at the tap symbol is interactive. If the user clicks on these collider boxes a module interface as shown on Fig. 3 is created. With these module-specific interfaces, a user can interact with the module of the plant. They are always located directly at the real component of the plant, which offers the advantage that the individual module interfaces can be clearly assigned to the assemblies. When using them, according to Fig. 3 the user sees white frames at the positions of the real modules with a tap icon in the middle. By aiming and executing the tap gesture, module menus can be called up, which open above the module interfaces.

Via the menus that are given in the module-specific interfaces, the user can control and monitor the respective modules of the system individually. These are provided with clickable buttons as shown in Fig. 3. The clickable buttons offer commands such as

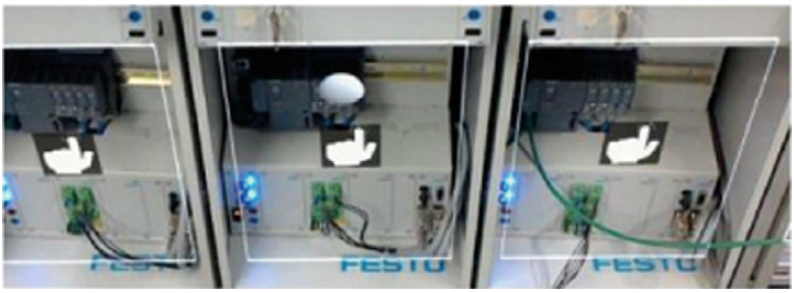


Fig. 2. Collider Boxes with tab symbol

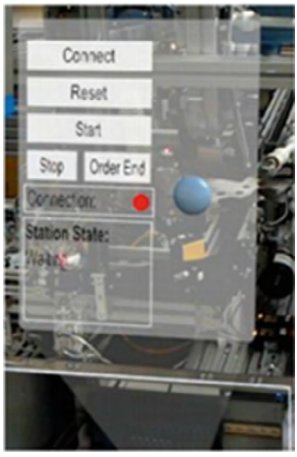


Fig. 3. Module interface

connecting, starting or stopping the module. In addition, the status of the module is visible.

For further monitoring of the plant, additional user interface elements are distributed for various modules and assemblies, which display assembly-specific information from sensors. These elements are also placed directly at the real assemblies in order to clearly assign them. This also offers the advantage that both the sensor displays and the real assemblies are in the user's field of vision and can thus be observed in parallel.

2.3 Control Panel

The control panel was developed for the central control and monitoring of the entire model factory, which is visibly displayed to the user in the mixed reality view after the program starts. Both the visual design of the control panel and the selection of the functions to be implemented were based on conventional industrial panels with touch operation [7].

By analyzing various modern industrial panel user interfaces, it was possible to work out that user interfaces mostly consist of the same subareas. The most important subarea is the one in which various information to be displayed is shown. In the case of touch user interfaces, this area can also be used to interact with the machine. In most cases, this area took up the largest part of the display area. As soon as a user interface consisted of more than one page, a separate menu was used for navigation. To improve orientation, this navigation area was permanently displayed, independent of the previously described subarea. In most cases, the navigation was positioned on one of the four side panels. Another subarea of the analyzed industrial panels was the status bar. This was used to display the states of individual plant modules, any error and warning messages or the time and date.

Based on the results of the analysis, the aim was to integrate the display area, navigation area and status bar in the design of the control panel. Figure 4 shows the control panel and the subareas described. The left side of the panel includes the status bar and the navigation area. The right side of the panel includes the display area, where selected information is shown.

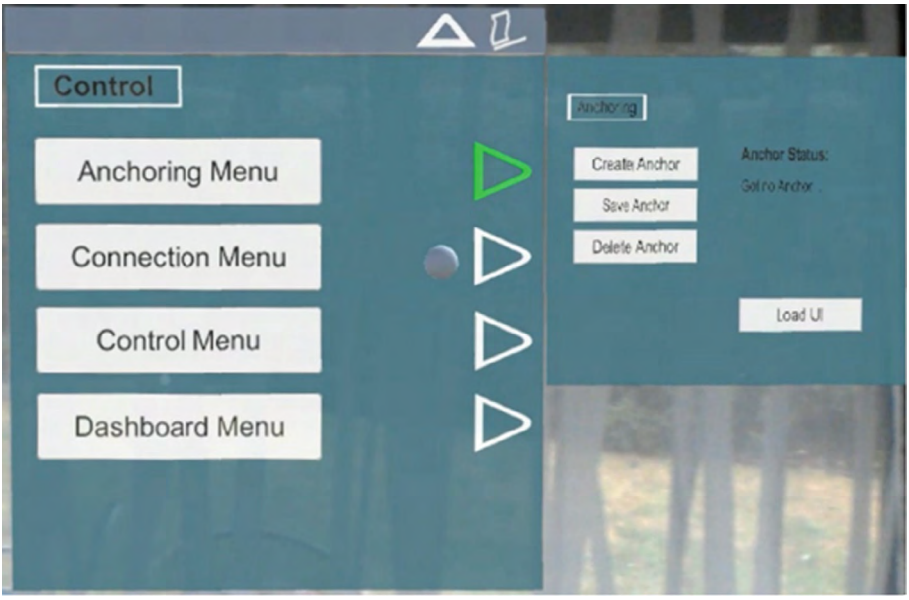


Fig. 4. The control panel

The appearance of the virtual buttons is like that of real buttons that can be pressed manually. When interacting with a button, visual feedback is given by the selected button changing its color from light gray to a slightly darker gray for a short moment. The short darkening is based on the actuation process of real buttons. A further feedback on interaction with a button is given by the color change of an associated arrow, which is positioned to the right of the respective button. This should additionally indicate that, and which content is displayed on the right side of the control panel. As long as content

is displayed on the right side of the control panel, the associated arrow remains colored. The status bar is located at the top of the navigation area and is separated from it by color and a three-dimensional geometry that is recognizable to the user.

The colors of the control panel were chosen so that all displayed content is easily recognizable in the mixed reality view. The given lighting conditions of the real environment have a great influence on the HoloLens in this respect. In addition, the control panel was designed to be transparent and optimized so that both the virtually displayed content and as much of the real environment behind the displayed content is and remains recognizable.

To take full advantage of AR technology, the control panel should be visible and operable by the user not only when he is standing directly in front of the model factory, but also beyond. Nevertheless, it is important that the user's view is not restricted by the panel even though there is no need for interaction with the model factory at the time. For these reasons, it was designed so that the control panel follows the user's gaze and is positioned continuously on the right side of the field of view. When the point of view changes the panel is following with a little inertia. With a faster turn of the user's head to the right he can reach the panel with the curser of the augmented reality device. As soon as the curser hits the panel, it holds its position in space. When the curser leaves the control panel it moves back to its position in relation to the user to the right side of his field of view. It is also possible to fix the position of the control panel in space therefore it is not following the user anymore. This function has been integrated in case the user prefers a fixed place for the control panel and can be executed by an interactive element in the status bar.

2.4 Dashboard

In addition to the control panel, a dashboard can be opened on the left of the field of view, as needed. The idea behind the dashboard is to add selected sensor displays to a dashboard panel that can be moved and fixed independently of the main control panel. The goal was to enable location-independent monitoring of selected sensors. For example, the dashboard can be taken to the workplace and fixed there. The dashboard can be opened and closed via the control panel. In case the dashboard is needed but has been fixed somewhere else, it can be brought back into the user's field of view at any time via the control panel. Figure 5 shows the dashboard in the mixed reality view with displayed values of the filling station of the model factory. The visualization of the dashboard was based on the control panel.



Fig. 5. The dashboard

3 Outlook

Currently, the application is being refined so that it can be tested as part of an evolution after the Covid 19 restrictions end. The application and initial evaluation results will be presented at IHIET2021.

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Digital Filters: A New Way to E-Wear Jewellery

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Abstract. The objective of the paper is to analyse how digital technologies are used in jewellery design in an era in which products and environments are becoming increasingly intangible to leave space to digital worlds, thanks to augmented and virtual reality. The paper gives an outline of jewellery within the contemporary scenario, analysing the direction traced by digital technologies within the jewellery system as well as the impact of virtual environments. To this end the contribution describes the results of an applied research case study developed during a five-day design workshop at Politecnico di Milano. The aim of the experience was to explore the contribution of digital and virtual tools in shaping and conferring value to jewellery items. In conclusion, the paper analyses the outcome of the case study in terms of concepts of preciousness and wearability, being defined based on personalization, interaction, and fruition.

Keywords: Jewellery design · Virtual environments · Digital ornaments · Innovation

1 Introduction

Historically, jewellery has always been a middle ground between art, craftsmanship and design. Ambiguous objects with contrasting values, from unbridled luxury to conceptual avant-garde, from the dazzling preciousness of materials to more or less latent design values. On the one hand there is art, with the concept of authorship, on the other fashion, with the fleeting nature of its present, and in the middle jewellery, with the defence of precious materials as bastions of eternity [1]. For a long time, the value of a piece of jewellery was synonymous with its preciousness, i.e. the physical cost of the material. Today this idea is outdated. The value of a piece of jewellery is the result of the quality of the project, the ability of the designer or artist to generate a storytelling around the object thanks to the choice of form, material, or production technologies [2]. In the past, jewellery was linear and sequential; today it is fragmented, heterogeneous and multiple. In all this complexity, digital technology and the transition from physical systems to digital ones, further subvert the values that orbit around the world of jewellery [3]. Physical products are today complemented by virtual twins, which can in turn be worn and displayed through screens. Virtual items are designed digitally with high photorealistic features but rather than be produced, they remain virtual and are used online, for their social media, their avatars, on life simulation video games. Brands take

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 837–843, 2022.
https://doi.org/10.1007/978-3-030-85540-6_106

action to design and extend their online presence with augmented reality try-on and virtual appointments that allow them to satisfy customer needs with an inclusive and virtual experience [4]. This leaves increasing importance to the experiential component, where the user interaction plays a predominant role. Indeed, for example, the digital realm opens unprecedented possibilities in terms of personalization, enabling products to look and actively respond accordingly to the wearer's will and behaviour [5]. A growing number of software programs have been developed to support the process within the jewellery sector value chain: once a 3D virtual shape is created, its aesthetics can be digitally modified, changing proportions and colours. Moreover, in this way, jewellery can be virtually tested, even in its immaterial phase. This is made possible thanks to Virtual Prototyping and Augmented Reality, which allow users to interact directly with digital products as if they were physical [6]. In a dimension where most purposes are forcibly dematerialized and filtered through screens, technology is increasingly used to enhance digital social experiences, not only among peers but also in the dynamics of interaction with brands, from purchase to product use.

2 Directions Traced by Digital Technologies (VP e AR)

The virtual space is increasingly the place where new buying and wearing dynamics are forming, close to the new generations. According to Epson [7], 75% of European consumers would change their shopping behaviour if retailers were more experiential. This means consumers would shop more often and retailers would be able to attract more younger consumers: Millennials (67%) and Generation Z (65%) continue to be attracted to shops that offer experiential elements. This finding provides an opportunity for jewellery retailers to start taking advantage of experientialism by adding immersive elements to their marketing strategy. Interest in immersive technologies has surged as brands have begun to realise the importance of integrating them into their digital strategy [8]. According to Shopify statistics, products enhanced with augmented reality integration showed a 94% higher conversion rate than others [9]. A Retail Perceptions' report on augmented reality for retail [10] showed that most consumers would like to use this kind of technology to make the right purchasing decision, so, anyone with a smartphone or laptop can virtually try on the piece. The jewellery industry has always relied on offline interaction to facilitate sales. However, the market situations of the last year have accelerated the urgency for companies in every sector to go digital. The closure of physical shops has led to an inevitable migration of the customers to online channels motivating brands to invest in the development and application of new digital technologies. It is also estimated that "over the next five years, online sales of fine jewellery are expected to grow at a compound annual growth rate (CAGR) of 9 to 12%" [4]. This is the demonstration that augmented reality has created a successful virtual shopping space with the 'try-before-you-buy' function. Through augmented reality-powered virtual try-on, consumers can interact with the brand and its products, increasing engagement and sales numbers. Indeed, although digital leads to an inevitable dematerialization of reality [11] and can lead to an alienation of social interaction, the human aspect in online sales remains essential [4]. Through this system, jewellery brands also can access consumer data. They can then use these technologies to track the performance of their products and

perform in-depth customer analysis. Brands such as Tanishq, De Beers and Boucheron have already moved in this direction and have seen a significant increase in online traffic and transactions leading to increased sales.

But today, it is not only about digitising the shopping experience, but also the virtual dimension is the opportunity to create dematerialised, intangible products that can only be purchased and worn through avatars. Caronia's virtual bodies [12] begin to take shape: the digital permeates identities, shaping one or more of digital bodies, which can be dressed and can act in a virtual environment. Today, indeed, consumption occasions are changing, and the pandemic has only accelerated a long-standing process of digitisation: in this context, technology is increasingly used to enhance the social digital experience among users. We may talk about digital wardrobes: even if a jacket, bag, or a pair of sneakers are not real, users can still wear them as Instagram filters in any video, photo or story they post. Some brands are born in the digital environment and evolve as physical collections, brands capable of communicating with a younger generation on social channels [4]. It is possible for example to simulate brands' products through social media filters, studying the information contained in the simulation, such as engagement, demographics and psychographics. Eventually producing in real life, the products as filters that retain the most appealing metrics. This allows to save a huge number of natural resources in the process. This is for example the case of Impossible Brands. This model can be referred to as virtual-to-consumer. It allows to introduce a fast digital fashion, made of thousands virtual products, simulated by their digital twins, and a slow physical one, made of limited, data-driven physical collections. Through virtual reality customers can become models at the same time. They can parade with the garments they intend to buy and interacting with other customers. They can decide to buy the physical piece, or just its virtual version.

3 Applied Research: A Digital Tailor for Intangible Jewellery

Based on these reflections, we conducted an applied research experience in the educational sphere to explore the contribution of digital and virtual tools in shaping and conferring value to jewellery items. The experience consisted in a five-day design workshop at the Specializing Master in Accessory Design at Poli.Design, the consortium company of the Politecnico di Milano, Milan. The short course involved 13 masters' students and it was specifically aimed at investigating the impact of digital technologies in the jewellery sector, focusing on the way today's businesses can be transformed toward faster, smarter, more efficient, and sustainable pieces.

3.1 Workshop's Design Aims

The workshop addressed

1) the definition of general research of jewellery styling thanks to the creation of a map of jewellery piece-face winning associations for the following micro-categories: (i) harmony of colours (colour palette, seasonal colour analysis, stone, precious metals in accordance to skin, hair, eyes colour); (ii) harmony of proportions (defined by the

relationship between body anatomy and jewellery length, volume, shape, lines); harmony of composition (layering of the products and creating suitable compositions);
2) the research of jewellery styling. Starting with the rules emerged from the previous research and data from assigned products, students had to create winning combinations that could best enhance each person;
3) the design development of a jewellery item that perfectly matched with their own body features. Students had to ideate and design the most suitable jewellery piece starting from the characteristics of one's own face (identifying oneself in one of the profiles traced during the research phase). The jewellery item had not been produced physically but conceived as a digital filter.

3.2 Methodology

The workshop was structured around a specific brief: students were asked to design jewellery digital pieces starting from the characteristics of users'/wearers' own aesthetic features: harmony of colours, proportions, and composition. They were asked as well to imagine an app which, by scanning the face, could suggest the most suitable jewellery piece for each user, in the manner of a digital tailor.

The actors involved in the workshops:

- 3 teaching staff members from the Politecnico di Milano, both from the fashion design field;
- 13 masters' students.

The workshop took place over 5 days, from Monday to Friday, full day. The combination of lectures and the learning-by-doing approach was chosen as teaching method, guiding students throughout the design process. In particular, the lectures dealt with issues related to jewellery design, fashion tech, value in fashion and jewellery design, communication design and methods of visual communication. For each day the learners had specific activities to address. The students were first asked to work in small groups to research and map jewellery piece-facial features winning associations (1) and to create winning combinations that could best enhance each persons' aesthetic features (2) The design phase (3) was then conducted by each student individually. The didactic methodology consisted in a learning-by-doing part with constant reviews by the teaching staff, from research to ideation, from conceptualization to the digital prototyping.

A peer observation marked a continuous monitoring process throughout the duration of the workshop, combined with a final informal discussion to share opinions and results around the week of the workshop.

3.3 Workshop's Delivery Instructions

Students on the first day were asked to produce the following material for the final digital delivery on the 5th day.

- 2 boards // research on harmony of colours (inspiration images + keywords + colour palette + max 300 characters description)
- 2 boards // research on harmony of proportions (inspiration images + keywords + max 300 characters description)
- 2 boards // research on harmony of composition (inspiration images + keywords + max 300 characters description)
- 1 board // mood board
- 1 board // concept + technical details
- 1 board // digital prototype including a simulation of the digital filter

3.4 Output

Halfway between the physical and virtual realm, the project aimed to open new possibilities of wearing jewellery, not only in the real dimension but also through filters that could best adorn the user's digital body. The latter also becomes the subject of research and design: not only the jewel is designed, but also the digital interaction that connects the jewel-filter to the user, implementing the digital experience The experience highlighted constraints that were no longer those of the traditional production, but the ones of a virtual reality in which precise frames delimit the spaces of wearability Figs. 1, 2 and 3.

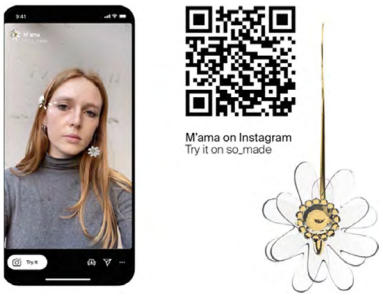


Fig. 1. M'ama by Sofia Martinelli. Starting from the seasonal colour analysis and the proportion theory, M'ama was designed to enhance the personal features of the wearer: oval face, medium neck length, long hair and Spring colours. M'ama represents childhood memories of spring, pulling off daisies' petals saying "m'ama, non m\ama" (Italian for Love me Love me not). Its will is to bring back to adulthood these playful memoirs in a contemporary jewel.

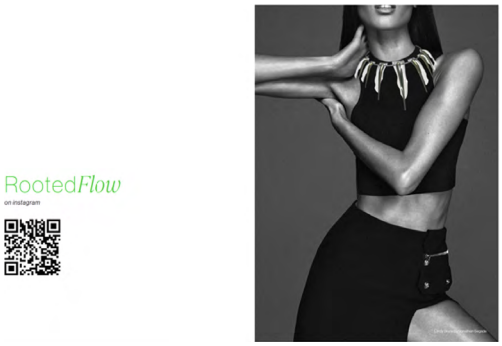


Fig. 2. RootedFlow by Benedetta Molea. A digital necklace inspired by two pillars of the students personality: strong roots and ability to flow. Indeed, this piece want to express both fluidity and stillness through its shapes.

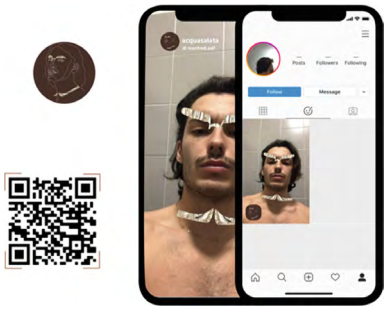


Fig. 3. Acquasalata by Manfredi Cacioppo. Winter skin tones matches with metals like white gold and copper that enhances this natural palette of cold colours; long squared face and medium neck match with rigid necklaces; the wavy long hair matches with choker, matinée necklaces and rigid ones. The jewel is inspired by fluid, organic, shiny and wavy shapes.

4 Conclusion

The paper analysed how digital technologies are used in jewellery design in an era in which products and environments are becoming increasingly intangible to leave space to digital worlds, thanks to augmented and virtual reality.

The paper gave an outline of jewellery within the contemporary scenario, highlighting how the value of a jewel has been progressively changed with the digital shift, marking the increasing importance of the immaterial aspect related to the experiential component, where the user interaction plays a predominant role. This is exemplified by the possibilities offered by the digital realm in terms of personalization, enabling products to look and actively respond accordingly to the wearer's will and behaviour. The user becomes a co-creator of contents and meanings, and the personalization of the online experience increases the loyalty and connection with the brand.

Subsequently, the paper analysed the direction traced by digital technologies within the jewellery system as well as the impact of virtual environments: technology is increasingly used to enhance digital social experiences, not only among peers but also in the dynamics of interaction with brands, from purchase to product use.

Lastly, the contribution described the results of an applied research case study developed during a five-day design workshop at Politecnico di Milano. Students worked on the design development of jewellery digital pieces starting from the characteristics of users'/wearers' own aesthetic features: harmony of colours, proportions, and composition.

The case study is intended as a starting point to consider an alternative approach to the traditional concept for the jewellery world. In the current market scenario, companies should be proactive in considering new technological advances and integrating them to provide a better consumer experience. The presence of digital selves [13] is growing, non-physical users who can act in virtual environments and whose digital presence can be designed. The current pandemic has acted as a catalyst for this digital transformation. Whether it is try-before-you-by or products that are only meant to be bought and worn digitally through avatars, virtual is an opportunity for brands to integrate immersive technologies into their business models to create immersive experiences for their customers.

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Design of a HVAC System Based on Confluents Jets Applied in Office Spaces

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Abstract. This numerical study, made inside a virtual office, considers a Building Thermal Response software to evaluate the surrounding surfaces, a CFD software to evaluate airflow around the occupants and the indoor air quality and a Human Thermal Response to calculate the occupants' temperature distribution and the thermal comfort level. This study considers a Heated, Ventilation and Air Conditioning system constituted by an inlet and exhaust systems. The inlet system, based on confluent jets, is built with horizontal ducts, located on the sides of the room, equipped with nozzles to promote vertical jets. The exhaust system is founded on a vertical duct, placed in the ceiling central area. The virtual office is occupied by four persons seated around a table. The Air Diffusion Index (ADI) and Air Diffusion Turbulence Index (ADTI) are calculated for winter typical conditions. The results show that ADI and ADTI improve with increasing inlet air velocity.

Keywords: Building Thermal Response · CFD · Confluents jets · Human Thermal Response · Indoor air quality · Thermal comfort

1 Introduction

Confluent jets system defined as jets issuing from different apertures in the same plane flow in parallel directions until at certain distance downstream they coalesce and follow as a single jet. The distance from the outlets at which the jets merge depends on the distance between the area of the outlets. More details are shown in Awbi [1].

The Air Distribution Index (ADI), which depends of the thermal comfort number (TCN) and the air quality number (AQN), was presented in Awbi [1]. This method was developed for uniform thermal environments, and includes the thermal comfort (TC), the indoor air quality (IAQ) and the ventilation effectiveness, namely the effectiveness for heat removal (εTC) and the effectiveness for contaminant removal (εAQ). Later,

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 844–850, 2022.
https://doi.org/10.1007/978-3-030-85540-6_107

the ADI was adopted by Conceição et al. [2] for non-uniform thermal environments and also allowing to be used in multi-occupation spaces. Recently a new index named Air Distribution Turbulence Index (ADTI) have been proposed. This new index is used to consider simultaneously the TC, IAQ, Draught Risk (DR), εTC, εAQ and room air removal (εDR) [3].

To evaluate the TC level is used the Predicted Percentage of Dissatisfied people (PPD) index, developed by Fanger [4] and presented in ISO 7730 [5]. The application of the thermal comfort models or others, including control models, both in numerical and experimental studies, can be analyzed, as example, in the works of Conceição et al. [6–9]. To evaluate IAQ level in occupied spaces is used the carbon dioxide (CO_2) concentration, release by the occupants, which is the IAQ indicator adopted by the international standard ASHRAE 62.1 [10]. As an example of the application of this indicator, the works of Conceição et al. [11–13] can be consulted. To evaluate the occupant local thermal discomfort, associated to the ventilation principles, is used the DR index. DR is function of the air temperature, air velocity and air turbulence intensity [3]. DR was developed by Fanger et al. [14] and it is presented in ISO 7730 [5].

In the assessment of ADTI are used three research software: Building Thermal Response (BTR), Human Thermal Response (HTR) and Computer Fluid Dynamics (CFD) [15]. BTR software model simulates the thermal response of the building and calculates numerically the internal temperature and surrounding compartments surfaces temperatures [16]. Some applications of this software can be found in the works of Conceição et al. [17] and Conceição and Lúcio [18–20]. The HTR numerical model simulates the human thermo-physiology and evaluates the human TC sensation, the tissue and clothing distribution temperatures [16]. Applications of HTR are found, for example, in Conceição et al. [21–23]. Others numerical models, related with human thermal response, can be consulted in Tang et al. [24] for the simulation of the local skin temperature in older people, and in Ozeki [25] for the assessment of TC level of occupants subjected to solar radiation. CFD is a differential numerical model and can be used to simulate the airflow and evaluate the air quality, air temperature, air velocity, air turbulence intensity and CO_2 concentration [26]. Other studies related with CFD techniques can be found in Takabayashi [27] and Nilsson and Holmer [28].

The aim of this study is to evaluate the performance of a new HVAC system, based on vertical confluent jets, using the ADI and ADTI indices. This study was carried out for three values of the airflow rate provided by the HVAC system.

2 Models and Materials

This numerical study considers a coupling of:

- A differential numerical model, that simulates the CFD. The CFD model evaluates the air velocity, air temperature, air turbulence intensity and CO_2 concentration. Using this information, this numerical model evaluates the DR around the occupants and the IAQ level;
- An integral numerical model, that simulates the response of the human thermal, thermoregulatory and clothing thermal systems. It is used to evaluate the distribution temperatures of the tissue, blood and clothing.

The inlet system is made with two ventilators coupled to two horizontal ducts, with a diameter equal to 125 mm, each one located along the side surfaces of the wall (see Fig. 1). The inlet airflow, with descendent airflow, is located 1.8 m from the floor. The average air insufflation velocity, used in the simulation for the three situations considered in this study, are as follows: 0.63 m/s (Case A); 0.84 m/s (Case B); and 1.05 m/s (Case C). The average inlet air temperature for the same above three situations are as follows: 17.7 °C (Case A); 18.3 °C (Case B); and 18.6 °C (Case C). The exterior air temperature considered for winter conditions was 0 °C. The exhaust system, located 1.5 m from the floor, is equipped with an exhaust ventilator.

In Fig. 1, the inlet air velocity field of the inlet ventilation system is represented in blue color. The virtual chamber has a square table and four occupants sitting on each side of the table. Each occupant is 1.70 m tall and 70 kg in weight. Numerical simulations were carried out for a winter typical day conditions with an indoor air relative humidity of 50%. For the Cases A, B and C, it was considered that the occupants have an activity level of 1.2 met and that their level of clothing is equivalent to 1.0 clo, a typical value for winter conditions.

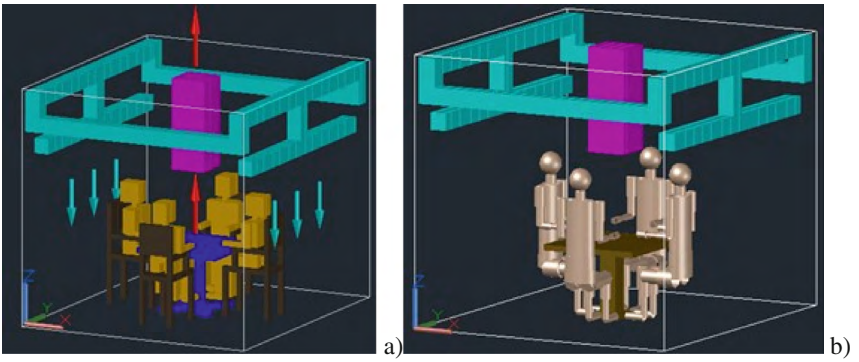


Fig. 1. Scheme of a virtual chamber, equipped with a HVAC confluents jets system used in the: a) CFD software; b) HTR software. Cyan arrows represent the inlet airflow and the red arrows represent the outlet airflow.

3 Results and Discussion

The ADI and ADTI values are presented in Table 1 for the three studied Cases A, B and C. In the Table 1, PD represents the percentage of dissatisfied people related to the air quality [5], and DRN represents the DR number [3].

For the Case C, the distributions of air velocity, air temperature and DR around the human body sections are presented, respectively in Fig. 2, Fig. 3 and Fig. 4.

The results show that when the airflow is increased, the effectiveness for contaminant (εAQ) and room air removal (εDR), the PPD, AQN, DR, ADI and ADIT values increase. On the other hand, the effectiveness for heat removal (εTC), the concentration of CO_2 in the breathing area, TCN and DRN decrease. For case C, it is verified that the average

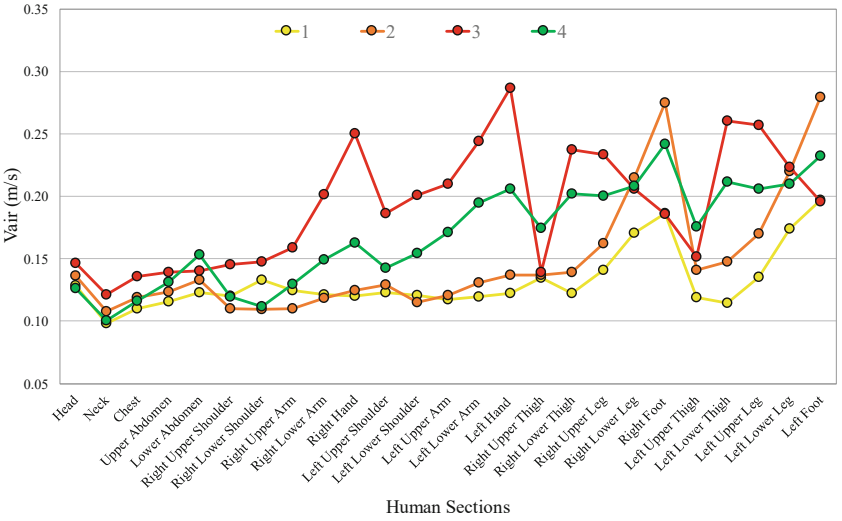


Fig. 2. Distribution of air velocity (Vair) around the human body sections for the Case C.

concentration of CO_2 in the breathing area is close to the acceptable limit [10], the average TC level of the occupants, given by the PPD, is acceptable according to category B [5], and the average DR is acceptable according to category A [5]. Increasing the airflow rate, the ADI and ADIT values increase, which shows that the performance of the HVAC system improves with the increase in airflow rate, although there is a small decrease in the TC level of the occupants.

Table 1. ADI and ADTI for the three Cases studied, depending on the inlet air velocity.

Case	**A**	**B**	**C**
εTC (%)	37.87	35.16	35.90
PPD (%)	6.73	7.20	7.87
TCN	5.66	4.90	4.60
CO_2 concentration in breathing area (mg/m^3)	7790.78	3968.46	2012.46
εAQ (%)	13.24	12.41	15.20
PD (%)	5.17	3.74	2.86
AQN	2.56	3.32	5.31
εDR (%)	82.46	92.28	94.70
DR (%)	5.16	6.14	8.01
DRN	15.97	14.99	11.88
ADI	**3.23**	**3.53**	**4.61**
ADTI	**5.19**	**5.57**	**6.24**

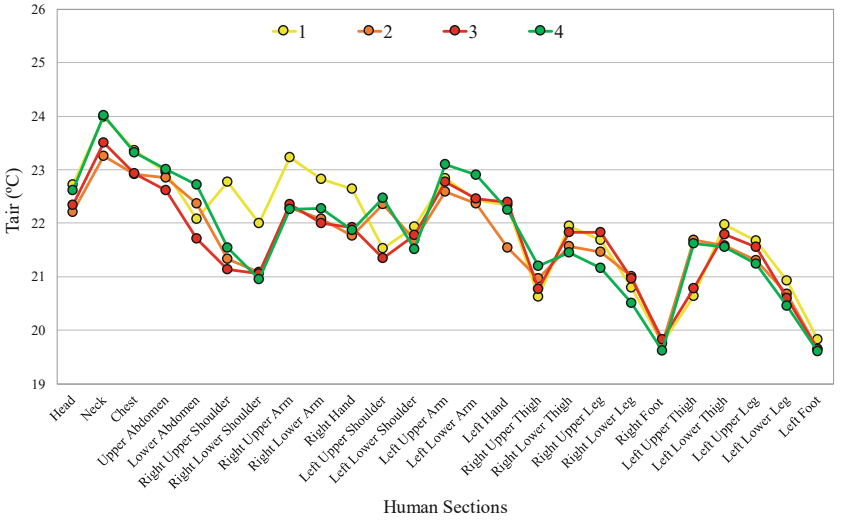


Fig. 3. Distribution of air temperature (Tair) around the human body sections for the Case C.

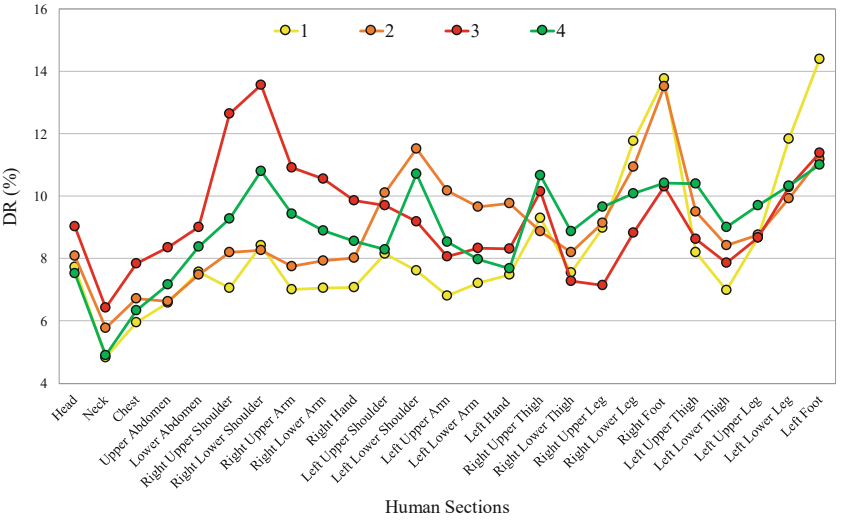


Fig. 4. Distribution of DR around the human body sections for the Case C.

The air velocity around the occupants varies between 0.10 m/s and 0.3 m/s. In general, the highest values are found in the lower sections of the human body and the lowest values are obtained in the upper sections of the human body.

The air temperature around the occupants is generally similar for all occupants, ranging from 19.5 °C to 24 °C. In general, the highest values are found in the upper sections of the human body and the lowest values are obtained at the feet of the occupants.

The DR around occupants ranges from about 4% to slightly above 14%. In general, the highest values are found in the lower sections of the human body, especially near the feet, and the lowest values are obtained in the upper sections of the human body, especially in the neck and chest.

4 Conclusions

In this article, a HVAC system consisting of an inlet system based on vertical confluent jets and an exhaust system located in the central zone of the ceiling was presented. Its performance was evaluated using the ADI and ADTI indices for different flow rates. The simulation of its performance was carried out in a virtual office occupied by four people seated around a central table.

According to the mainly results, it was found that the performance of the HVAC system improved with increasing input air velocity. Acceptable values of thermal comfort (according to category B [5]) of the occupants and DR (according to category A [5]) were obtained, and values close to acceptable were also obtained for IAQ [10].

Acknowledgments. The authors would like to acknowledge to the project (SAICT-ALG/39586/2018) from Algarve Regional Operational Program (CRESC Algarve 2020), under the PORTUGAL 2020 Partnership Agreement, through the European Regional Development Fund (ERDF) and the National Science and Technology Foundation (FCT).

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Artificial Intelligence and Computing

Design and Study of Energy and Comfort in an Office Space Using a Coupling of Human and CFD Numerical Software

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Abstract. This numerical work developed and analyzed a HVAC system, based on horizontal confluents jets system, in summer typical day conditions placed in a virtual office chamber. Presents and applies a numerical model, developed by the authors in the last years, that considers the coupling of the CFD and HTR. In the input data are used the Computer Aided Design geometry, the location of the occupants and the external environmental variables, while the occupants' geometry is generated by empirical equations, based in height and weight. Above the head level, six air ducts, connected to the ceiling area, compose the exhaust system. The inlet system was based on four vertical ducts with 0.15 m diameter, located on the corner of the office chamber, are equipped with consecutive holes who promotes horizontal jets near the wall. The thermal comfort, the indoor air quality, the Draught Risk, the effectiveness for heat removal, the effectiveness for contaminant removal and the ADI are evaluated.

Keywords: Human Thermal Response · CFD · Computer aid design · ADI · Draught Risk

1 Introduction

To provide acceptable microclimate in the indoor space, like office spaces, being controlled by a Heating, Ventilating and Air-Conditioning (HVAC) system, we have to achieve and guarantee acceptable thermal comfort, air quality and local thermal discomfort levels. In this context, microclimate refers to thermal environment as well as air quality. The airflow promoted by a HVAC system that is distrusted in the office space using a principle of mixing, displacement and crossed ventilation, confluents jets, impinging system, personalized ventilation, and others.

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 853–859, 2022.
https://doi.org/10.1007/978-3-030-85540-6_108

In this study the horizontal confluents jets principle is used. For more details, see the works of Arghand et al. [1], Karimipanah et al. [2] and Cho et al. [3].

To evaluate the thermal comfort level in this work is used the Predicted Mean Vote (PMV) index and the Predicted Percentage of Dissatisfied people (PPD) index, developed by Fanger [4] and presented in ISO 7730 [5]. To evaluate the indoor air quality level is used the carbon dioxide (CO_2) concentration, release by the occupants, used as indicator of the indoor air quality in occupied spaces ASHRAE 62 [6]. Application of this method can be seen in Conceição et al. [7, 8]. To evaluate the Draught Risk, DR, was used a model presented in Fanger et al. [9] and presented in ISO 7730 [5].To evaluate the HVAC system performance is used the Air Distribution Index, ADI, see in Awbi [10], for uniform environments, and Conceição et al. [11], for non-uniform environments.

In this work the application of the horizontal confluents jets system is applied, namely, using jets near the wall and near the floor in an office space equipped with eight seated occupants.

2 Materials and Methods

2.1 Numerical Model

In this work the numerical model was divided in two parts: a coupling of a differential numerical model, Computational Fluids Dynamics, CFD (see Fig. 1b), and an integral numerical model, that simulates the Human Thermal Response, HTR (see Fig. 1c), and an integral numerical model, that simulates the Building Thermal Response, BTR.

The differential CFD model evaluates the air velocity, air temperature, air turbulence intensity, CO_2 concentration, DR and the air quality. More details can be seen in Conceição et al. [11].

The integral HTR model, that simulates the human thermal, thermoregulatory and clothing thermal response, evaluates the tissue, blood and clothing temperatures distribution. More details can be seen in the works of Conceição et al. [11–15].

The integral numerical model, that simulates building thermal response, evaluates the air temperature distribution, surfaces temperature distribution and energy consumption. More details can be seen in Conceição et al. [11, 12, 16–23] and [23].

In the numerical validation, see Conceição and Lúcio [12, 13] for the HTR, Conceição and Lúcio [12] for the CFD and Conceição et al. [24] for the BTR.

2.2 Numerical Methodology

This numerical study is performed in a virtual office chamber with dimensions of 4.50 $\times$ 2.55 $\times$ 2.50 m^3 (see Fig. 1a), equipped with eight virtual occupants, one table and eight chairs, one exhaust system built with six vertical air ducts with a distance over the floor of 1.8 m height and one inlet system, based on horizontal confluents jets system, constituted by four horizontal ducts, with 0.15 m diameter and with consecutive holes located on the corners of the chamber.

The inlet and outlet airflow location, the occupants the desk and the seats used in the CFD numerical simulation can be seen in Fig. 1a. The design used in the HTR numerical

simulation can be seen in Fig. 1b. The location of the occupants and the number of each one can be seen in Fig. 1c. The numerical simulations were performed for a summer typical day conditions, with indoor mean air temperature of 25 °C, relative humidity of 50% and outdoor air temperature of 40 °C.

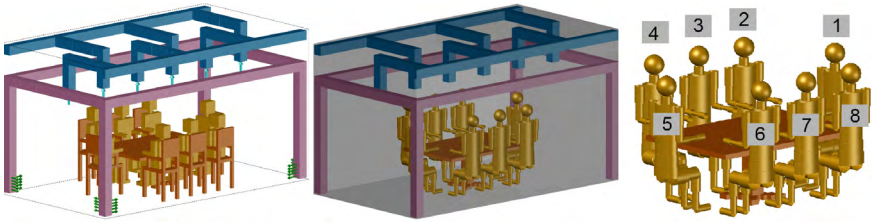


Fig. 1. a)- Virtual chamber used in the CFD as well as the location of the inlet (green arrows) and outlet airflow (light blue arrows); b)-Virtual chamber used in the HTR; c)-Location of the occupants in the office table.

A clothing typical level of 0.5 clo, was considered, with a typical activity level of 1.2 met, both refer for summer conditions. In the numerical simulation three study cases are made: Case A with a thermal power of 2778,6 W (with an airflow for 8 occupants), Case B with a thermal power of 4672,7 W (with an airflow for 16 occupants) and Case C with a thermal power of 6630,8 W (with an airflow for 24 occupants).

3 Results and Discussion

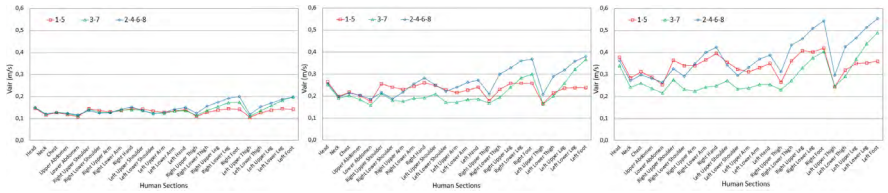
Eight occupants seated around the table are considered, two seated in the top table (occupants 1 and 5), two seated in each central area of the lateral table (occupants 3 and 7) and four seated in each lateral area of the lateral table (occupants 2, 4, 6 and 8).

3.1 Environmental Variables

In Fig. 2, 3 and 4 are presented, respectively, the air velocity, the air temperature and the DR distribution around the occupants.

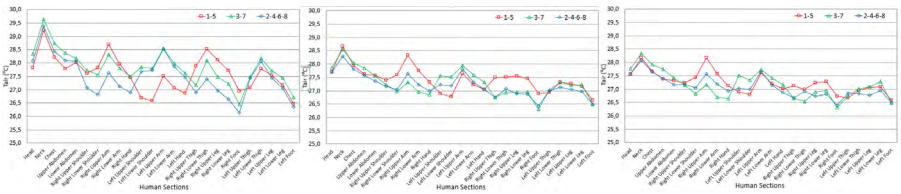
The results obtained show that:

- The air velocity around the occupants' sections increases when the inlet air velocity increases and are higher around the lower member than around the upper member;
- The air velocity around the lower member is higher when the occupants are seated in the lateral table than when the occupants are seated in the top table;
- The vertical gradient air temperature around the occupants' sections is similar in the three cases (A, B and C);
- The DR around the occupants' sections increases when the inlet air velocity increases and is higher around the lower member than around the upper member. For the Case A and B, DR was acceptable in accordance with the Category A. In the Case C was acceptable in Category B.



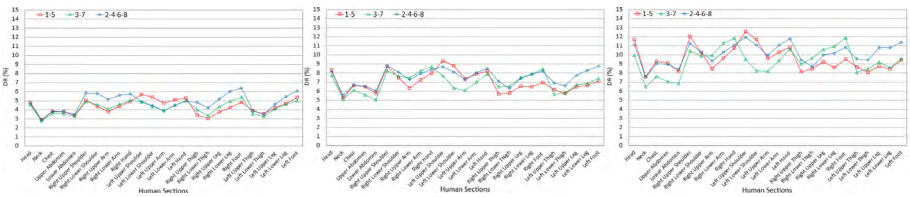
a) b) c)

Fig. 2. Air velocity around the occupants: a) Case A; b) Case B; c) Case C.



a) b) c)

Fig. 3. Air Temperature around the occupants: a) Case A; b) Case B; c) Case C.



a) b) c)

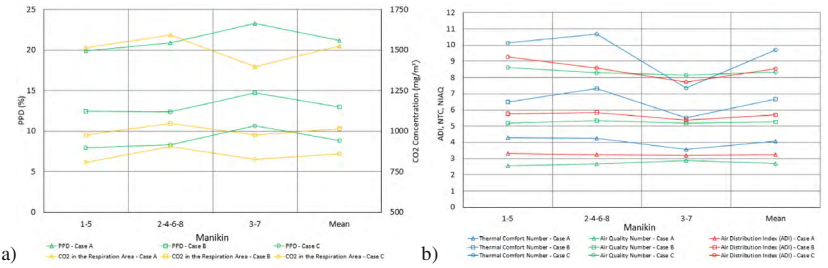
Fig. 4. DR distribution around the occupants: a) Case A; b) Case B; c) Case C.

3.2 Air Distribution Index

Figure 5a) presents the PPD and CO_2 concentration that the occupants are subjected, while Fig. 5b) shows the ADI, Number of Thermal Comfort and Number of Indoor Air Quality that the occupants are subjected.

The obtained results show that:

- The PPD index decreases when the airflow rate increases;
- The PPD is highest for the Case A and is lowest for the Case C;
- The PPD for the Case C is acceptable, according to the Category B;
- The CO_2 concentration decreases when the airflow rate increases and is lowest for the occupants seated in positions 1, 3, 5, 7 and is highest for the occupants seated in positions 2, 4, 6 and 8.
- The effectiveness for heat removal is higher than the effectiveness for contaminant removal;
- The thermal comfort number is highest for the Case C and lowest for the Case A;



a) b)

Fig. 5. PPD and CO_2 concentration a) and ADI b).

- The air quality number increases when the airflow rate increases;
- The ADI increases when the airflow rate increases;
- The ADI achieve the lowest value for the occupants 3 and 7.

4 Conclusions

In this work the application of a horizontal confluents jets system applied to a virtual office chamber, was analysed. The study, made in summer conditions, considers a virtual chamber occupied with eight occupants and equipped with one table, eight chairs, one outlet system and one inlet system.

The air velocity and the DR increase when the airflow increases, the air velocity, and the DR are higher around the lower member than around the upper member. This ventilation system, in accordance with the obtained values, in summer conditions, promotes acceptable DR in accordance with the category B.

The thermal comfort level and the air quality increases when the airflow increases. The Case C present the best air quality and thermal comfort level. The ADI increases when the airflow rate increases.

Acknowledgments. The authors would like to acknowledge to the project (SAICT-ALG/39586/2018) from Algarve Regional Operational Program (CRESC Algarve 2020), under the PORTUGAL 2020 Partnership Agreement, through the European Regional Development Fund (ERDF) and the National Science and Technology Foundation (FCT).

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Detecting a Coronavirus Through Breathing Using 3D Modeling and Artificial Intelligence

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Abstract. A coronavirus called COVID-19 appeared in Wuhan, China in December 2019. By early 2020 it caused a worldwide pandemic of a respiratory illness. This virus crisis affected the economy in the world in 2020 and will affect it in 2021, a lot of companies lost $ billions, especially the airlines, and because of that a lot of people lost their jobs; it also caused deaths of many people and till now it causes deaths of thousands of people in the world every day, a lot of people have died and till now a lot of people are dying every day because of a late detection of the virus in their bodies. The coronavirus can spread from an infected person's mouth or nose in small liquid particles, having different sizes, ranging from larger 'respiratory droplets' to smaller 'aerosols', when they cough, sneeze, speak, sing or breathe heavily, which means that it can be spread through breathing from an infected person to another person. There are different types (shapes) of COVID-19. This article aims to introduce a new approach that allows us to detect a coronavirus immediately using the artificial intelligence techniques and 3D modeling. The basic idea is to use 3D modeling technology to prepare the geometric data for different shapes of COVID-19 and AI technique, which can detect a coronavirus immediately through breathing by comparing the respiratory droplets or smaller aerosols with the shapes of COVID-19 specified by the 3D model .

Keywords: COVID-19 · Artificial Intelligence · 3D modeling · CNN

1 Introduction

COVID-19 stands for coronavirus disease of 2019 – 'CO' stands for corona, 'VI' for virus, and 'D' for disease. This disease was referred to as '2019 novel coronavirus' or '2019-nCoV'. The name "COVID-19" was given by the World Health Organization (WHO) on February 11, 2020 [1]. COVID-19 is an infectious disease that is caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), which was first identified in December of 2019 [2] (See Fig. 1). COVID-19 was declared as a pandemic by WHO on 11 March 2020 due to its fast globally spreading [3]. The symptoms of COVID-19 include fever or chills, cough, shortness of breath or difficulty breathing, fatigue, muscle or body aches, headache, loss of taste or smell, sore throat, congestion or runny nose, nausea or vomiting, diarrhea, chest pain, pink eye, rash [1, 4]. Globally,

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 860–866, 2022.
https://doi.org/10.1007/978-3-030-85540-6_109



Fig. 1. SARS-CoV-2 [6].

as of 23 February 2021, there have been 110.7 million cases confirmed of COVID-19 and over 2.4 million deaths since the start of the pandemic [5].

COVID-19 outbreak continues to surprise the world by its spreading with new variants. COVID-19 spreads during close contact and via respiratory droplets or smaller 'aerosols' produced when infected people sneeze, cough or cry. It may also spread during touching a polluted surface by the virus and then touching the mouth, nose, or eyes, through which it can sneak into the body. The studies show that the virus that causes COVID-19 can remain active on surfaces up to 72 h [7].

COVID-19 is a fraud virus, it sneaks into the body with a hidden form through respiratory system, searches for a weak place in it and lungs and starts preparing its army through reproducing, and when it finds the suitable moment to attack, it starts its war with the body through the respiratory system. The time for preparation of the army of this virus takes a few days. As known that symptoms may appear between two and fourteen days after exposure to the virus [4, 8]. Due to a late detection of the virus in the body, the virus may win.

After sneaking COVID-19 in the body, some symptoms may appear during 14 day, it depends on the immunity and the weakness of the body. The Reverse Transcription Polymerase Chain Reaction (RT-PCR) test is used for the detection of the virus from a nasopharyngeal swab by determining whether the expected viral genetic material was contained in the sample [9]. The problem of this test is the wasting time. The patient is considered infectious if the genetic material is found. However, if the genetic material is not found, this does not necessarily mean that the test person is not infected after all, the virus can be present elsewhere in the body but was not found in the sample [10]. Christian Drosten, an infectious disease specialist from Berlin's Charite Hospital compared this with an attempt to catch a goldfish in a tank with a hand net. He said: "if you pull the net out of the water and there is no fish in it, it does not mean that there are no fish in the tank", [11].

As was mentioned above, the problem exists in a late detection of the virus in their bodies. Moreover, due to the foggy results of some PCR tests since the virus can be in the body, but not in the sample for testing, which means that there is a need to detect the virus in the body at the first stages. This paper presents a proposal to detect COVID-19 immediately through breathing using 3D modeling and AI techniques.

There are different AI techniques and nanotechnologies that are used for image detection and shape recognition based on 3D modeling, such as deep learning techniques, AI microscopy, nanomaterial, nanoparticles, etc.

2 Related Research

This section provides a brief overview of works related to the 3D shape recognitions:

2.1 Deep Learning on 3D Shapes

One of the challenging topics in the AI field is the usage of deep learning models in medical image processing and analysis [10, 12]. A convolutional neural network (CNN) is one of the most common algorithms for deep learning. CNN can have tens or hundreds of layers that each learn to detect different features of an image [7, 13, 14]. They use filters at each layer and the output of each convolved image is used as the input to the next layer as shown in Fig. 2 [7].

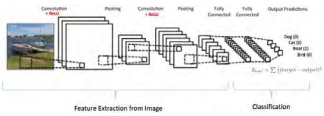


Fig. 2. Convolutional neural network [7].

Using deep learning approach with CNN simplifies the extraction of image data, which has been done before by standard image processing algorithms. There are different types of CNNs based on the structure of a hidden layer, such as SqueezeNet, ModelNet, MobileNet, Alexnet, Inception, GoogleNet, R-CNN, etc. [15, 16].

2.2 AI Microscopy

Artificial Intelligence based on Deep Learning is opening new horizons in biomedical research and promises to revolutionize the Microscopy field. CNNs are used to analyze microscopy data by interpreting the imaging data, which carried out by microscopy. AI has been applied in automated, classification and segmentation of microscopy images [17, 18]; resolution enhancement; and artificial labeling, which means extraction of structures from label-free microscopy imaging [19, 20].

2.3 Nanotechnology

Nanotechnology conducted at the nanoscale, which is about 1 to 100 nm. Nanotechnology and nanoscience can be used for many science fields, such as biology, chemistry, physics, etc. They are the study and application of extremely small things. Nanotechnology is used in medicine using nanoparticles. Particles are attracted to diseased cells, which allow direct treatment of those cells. This technique reduces damage to healthy cells in the body and allows for earlier detection of disease. There are different nanotechnology products, such as nanoparticles of a particular substance, carbon nanotubes, quantum dots for medical imaging, etc. [21, 22].

3 Detecting COVID-19 Through Breathing

The main problem of COVID-19 is its rapidly spreading among people. It is a hidden virus, which gives known about itself after domination over the respiratory system. COVID-19 is a single-stranded RNA, positive-sense, enveloped virus [23]. It has a diameter of 60–140 nm [24, 25].

A lot of studies have been done to detect COVID-19 through X-Ray images using different CNN models, such as modification of the VGG-19 classifier on ImageNet, which detects the virus using multilayer perceptron, (see Fig. 3) [26], and CNN model that extracts discriminant features from images using inception architecture [27]. Another study of COVID-19 detection through X-Ray images was based on deep SqueezeNet with Bayes optimization [10].

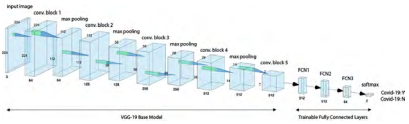


Fig. 3. Model architecture based on pre-trained weights of VGG-19 model [26].

Some studies of COVID-19 and other diseases detection have been done based on nanotechnology [27, 28]. Some studies uses sensors for detection some diseases, for example, sensor for pulmonary diseases from exhaled breath [29, 30]. Other studies have been done based on nanostructures of DNA/RNA [22].

This article suggests as a solution for the problem a new approach for an early detection of the virus through breathing, since this virus related to the respiratory system, by breathing heavily or blowing on a special glass. First, there is a need to have a dataset containing the 3D shapes of COVID-19 for all variants.

A sample test was done based on shapes of paper, since we do not have the required equipment to test COVID-19 virus. This glass can be set vertically or horizontally, a magnifying glass should be set under this glass with special sensors that can detect shapes having very small size (see Fig. 4 – contains four images).

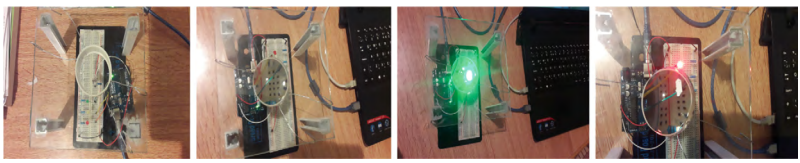


Fig. 4. Sample test.

In this sample test, we used a normal glass, put a magnifying glass under it (the two glasses can be changed by a smart glass with sensors) and used different shapes of paper then the LEDs turned on and off based on the shapes and the size of the shapes. In case

there is no object on the glass the green light turns on, otherwise the red or yellow LED turns on by depending on the size of the object.

For detection COVID-19 virus, when a person breathes heavily or blows on the glass, the respiratory droplets' or 'aerosols' spread and stick to the glass. After that, the particles of the droplets or aerosols will be detected if they have COVID-19 virus by using CNN techniques, AI microscopy technique or nanotechnologies. These techniques and technologies can detect COVID-19 virus using 3D shapes recognition by comparing the nanoparticles of the droplets or aerosols with the shapes contained in the database (dataset). In case the used technique detects identical shapes on the glass and in the dataset, the result will be positive, which means that COVID-19 is detected.

This approach can also compare, in addition to the shapes, the various components of COVID-19, such as size, weight, etc., and nanoparticles components, such as protein types.

4 Conclusion

The main objective of this article is to find as much as possible a logical solution for early detection of COVID-19 virus at the first stage of its sneaking in the body. This way, life of people can be saved as much as possible, since a lot of death cases due to COVID-19 are because of a late detection of this virus in the infected people.

This approach can be performed using different techniques, such deep learning, AI microscopy, nanotechnologies, in addition to creating a 3D model containing all the shapes and main characteristics of the particles components of COVID-19 virus.

Acknowledgments. The author would like to thank the president of Lebanese International University HE Abdel Rahim Mourad and the LIU Bekaa campus administration for their continuous encouragement of research activities at the university.

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Benchmarking Neural Networks Activation Functions for Cancer Detection

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Abstract. The choice of the most suitable activation functions for artificial neural networks significantly affects training time and task performance. Breast cancer detection is currently based on the use of neural networks and their selection is an element that affects performance. In the present work, reference information on activation functions in neural networks was analyzed. Exploratory research, comprehensive reading, stepwise approach, and deduction were applied as a method. It resulted in phases of comparative evaluation inactivation functions, a quantitative and qualitative comparison of activation functions, and a prototype of neural network algorithm with activation function to detect cancer; It was concluded that the final results put as the best option to use ReLU for early detection of cancer.

Keywords: Benchmarking · Activation functions · Neural networks · Cancer detection

1 Introduction

Computer-aided diagnostics (CAD) provides support in multiple areas of medicine with accurate results for decision making on the patient's current condition, eliminating the lack of data that the human eye does not perceive in the tests that each patient undergoes [1].

Neural networks (NN) are a set of neurons connected to achieve automatic learning of data by the powerful methods they use for abstraction; when extracting the information the NN can classify the characteristics, group them or give recognition of statistical analysis in the samples taken [2].

The activation function seeks to reduce data complexity by returning an optimal output from an input value (weights) in an NN and ensures that the proposed model improves its performance [3, 4].

In this research work we propose the analysis and selection of a neural network activation function, and at the same time propose the optimal activation function for the detection of cancer.

Why analyze neural network activation functions in cancer detection?

To understand the probability calculations in neural networks applied to samples that generate the most accurate results.

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 867–873, 2022.
https://doi.org/10.1007/978-3-030-85540-6_110

The objective is to perform a comparison of activation functions of neural networks in cancer detection.

Exploratory research, comprehensive reading, stepwise approach, and deduction are applied as a method.

2 Materials and Methods

2.1 Materials

A review of the activation functions used for cancer detection was carried out in 40 references, where it was found that the most used is ReLU, followed by Sigmoidal and Softmax.

The authors analyzed deep neural networks, which eliminates recursive features to achieve the classification of the input data set, used ReLU as the activation function because the model is easier to train [1]. According to the authors propose the multi-task CNN model for the prediction of attributes in images, multi-task transfer learning translates knowledge from non-medical to medical images, they chose the sigmoid-de function in the output layer as it acts as a classifier by only generating 0 or 1 [5]. The objective of the reference was to present a neural network model supervised with mixed methodologies to estimate the number and accuracy of affected persons. The activation function Softmax is a function sensitive to the data distribution, based on the estimation of the kernel of the problem [3]. Others propose to use deep convolutional neural networks due to the achievement obtained in pattern recognition performance and their great capacity for feature extraction; they defined ReLU as the activation function for convolutional layers, while for the clustering layers, the proposed methods are maximum clustering and average clustering; the Re-LU function accelerates the training speed since its derivative is 1 and its input will therefore be positive [6]. In another research they used a previously trained deep residual neural network, the neural network was given cancer or non-cancer information as ground truth; the Softmax activation function assigns decimal probabilities of an image and must sum to 1.0, allowed the training to converge faster [7].

2.2 Methods

Activation Functions. Each of the activation functions is composed of different or similar characteristics to achieve the function's objective, depending on the learning algorithm used, the number of layers, or the number of neurons in each hidden layer.

Benchmarking. This tool consists of measuring the performance and quality of services or processes under study, the following steps make up the phases of benchmarking [8].

- **Planning.** It is based on identifying what performance is to be measured and against what or whom. To do this, it is necessary to ask oneself… how is it going to be done?
- **Data collection and analysis.** It is the collection of data from different sources to analyze and identify their differences or similarities.

- **Implementation.** It consists of taking the analyzed information as a reference and adapting it to the proposed model and being able to add improvements.
- **Tracking.** Prepare reports highlighting the process to be used when the research needs to be taken up again at a later date.

Scope for results.

- Application of benchmarking phases.
- Benchmarking of benchmarks using the activation function.
- Selecting a lower cost and more efficient activation function.
- Apply the best performance activation function.

3 Results

The following results were obtained:

- Benchmarking phases inactivation functions.
- Quantitative/qualitative comparison of activation functions.
- Prototype neural network algorithm with activation function to detect cancer.

3.1 Benchmarking Phases in Activation Functions

To demonstrate the performance and accuracy with ReLU over other functions, different algorithms for early cancer detection were compared. The data sets for training the proposed models were based on tomographic and mammographic images. The performance of each algorithm is described below along with its activation function based on Table 1:

The proposed CFDNN algorithm for breast cancer detection is a somewhat rhythmic assembly for machine learning, aiming to achieve high accuracy with a lower computational expense. This algorithm uses the sigmoid activation function in the hidden layer, despite obtaining high accuracy, the sigmoid function requires excessive logic and converges slowly due to the division operations to which it is subjected.

The deep learning algorithm was proposed for the early detection of lung cancer, for the training of this algorithm they obtained a dataset with a group of patients with lung cancer and another group without any lesion or signs of lung cancer. They used Softmax as the activation function, it returns a vector of numbers in the range of [0, 1] with the desired output being 1, but, if the actual output is below 1, it will not correct the error.

The improved optimization method used in deep convolutional neural networks for skin cancer detection with ReLU activation function is widely used due to the high accuracy in classification and feature extraction of medical images. The max and min parameters of the activation function are defined as the size of the sliding window and minimum value to be accepted for the minimum of maximum clustering, thus reducing the system error and achieving better results than guarantee proper identification.

Table 1. Cancer summary and activation functions

Type of cancer	Algorithm efficiency	Activation function
Breast cancer	Achieved 93.5% accuracy in 10 runs [9]	Sigmoid
Lung cancer	Neural network prediction time was 2.3 ms per slice, sensitivity 95.9%, and accuracy 97.1% [7]	Softmax
Skin cancer	The proposed method showed 99.01% accuracy in the final results [10]	Rectified linear unit (ReLU)

3.2 Quantitative/Qualitative Comparison of Activation Functions

The activation functions that were used in the references were reviewed and the function descriptions are as follows (Table 2 and Fig. 1).

Table 2. Comparison of activation functions

Act. F	Advantage	Cost (time)	Efficiency %
Softmax	Efficient against loops and comprehension lists. Categorical distribution on class labels	Prediction time of 2.3 ms per slice	95.9% efficiency with a mixture of convolutional neural networks
Sigmoid	Translates remote input in $(-\infty; +\infty)$ to range in (0; 1). Mimics hot-coded labels	Produces the highest level of accuracy and minimum training time	The combined method yields 93.5% efficiency with 10% label noise
Rectified linear unit (ReLU)	The gradient does not disappear. Better convergence performance. Computationally more efficient	The function can stabilize the algorithm between 150 and 200 interactions	Displays 99.1% efficiency in artificial neural networks

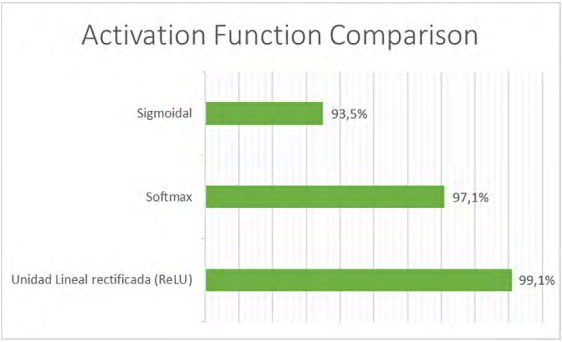


Fig. 1. Comparative graph of each of the activation functions by their efficiency.

The rectified linear unit (ReLU) activation function defined as $R(x) = \max(0, x)$ is the most commonly used activation function in neural networks because it provides

results with lower error since it allows positive values to pass through and passes negative values as 0; it provides greater downscaling in the output of the neural network, i.e., only those values that are higher will be considered as the back layer of the sliding grid [11].

3.3 Prototype Neural Network Algorithm with Activation Function to Detect Cancer

A gradient-based algorithm was proposed for solving linear equations, the system is preconditioned to ensure that the method converges.

```
Start
       Read quantity-Data set
       Read quantity-Enter
       Read quantity-Test
       Define data set (arrays)
        n = [quantity-Dataset images
                    (Train quantity-Enter, Tests quantity-Tests)]]
       counter = 1
       Define characteristics (Boolean)
           A = asymmetry
           B = border
           C = color
           D = diameter
        Create network
             image input layer ([x1 x2 x3 x4])].
             hidden layer ([h1 h2 h3])
             ReLU layer (activation function)
             fully connected layer
             convolutional layer
             output layer [classification ([y1 y2 y2 y3 y3 y4])])
       While (n != null or counter <= quantity-Dataset)
              Read image from data set
              If (image is Training or counter <= quantity-Train)
                      rain network (image, layers, features)
                      If ( n contains features )
                              Print(cancer)
                      Else
                              Print(no cancer)
                      EndIf
                      If (image is Tests or counter <= quantity-Dataset)
                              Test(image, layers, features)
                              If ( n contains features )
                                      Print(cancer)
                              Else
                                      Print(no cancer)
                              EndIf
                       EndIf
                      counter = counter + 1
                      advance next image
              End-while
       End-Algorithm
```

4 Discussion

Principles of the results: the proposed gradient-based algorithm solves systems of linear equations and is useful to be applied to large systems; the ReLU function converges and solves weight optimization problems and reduces the error in the network output.

Relationship of results: we compared the activation functions, their efficiency, and accuracy of each one; although the functions compete, the proposed ReLU function passes those positive values to the next layer after each convolution; this ensures that the information is not lost compared to sigmoid or tanh functions since both modify the inputs in closed ranges.

Generalizations of the results: the proposed activation function was adapted to the gradient-based algorithm in a deep convolutional neural network; moreover, the algorithm is computationally economical, capable of training sparse data efficiently.

Exceptions: although the ReLU activation function is the most commonly used, it is not recommended to use them in artificial neural networks because in ANN non-linear functions $Y = \sin(x)$ is used, while $Y = x$ is a linear function.

It is consistent with the results of this research that ReLU became the most widely used activation function in pro-fund neural networks [12]; the approach of the algorithm is based on gradient descent to minimize error.

5 Future Work and Conclusions

As future work, it was proposed to extend the research to study other activation functions such as the Swish function, which can train more pro-fund networks than ReLU networks. Swish continuously competes with ReLU in the task of image classification and translation in deep networks, the performance difference of the functions remains even when increasing the input batch.

It was concluded that the final results in the proposed method were very satisfactory, the very high accuracy of the results put ReLU as the best option to use for early cancer detection.

Acknowledgments. This work has been supported by the GIIAR research group and the Universidad Politécnica Salesiana.

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A Framework for Modeling Critical Success Factors in the Selection of Machine Learning Algorithms for Breast Cancer Recognition

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Abstract. Analysis of critical success factors allows software development organizations to focus on the factors to be successful. Selecting and implementing an algorithm for bosom cancer recognition could be hard. In this paper, a framework for modeling and analysis of success factors for the selection of Machine Learning methods used for the recognition of bosom cancer is presented. The objective is to analyze critical success factors in Machine Learning techniques selection for bosom cancer recognition built on Fuzzy Mental Maps. A group of common ML algorithms is presented in conjunction with the success factors. An analysis through measures calculation is presented in a case study. It was concluded that relevant factors for the selection of ML algorithms in the recognition of bosom cancer are: Selection of an ML algorithm according to the results, the study of ML algorithms tested in bosom cancer, obtaining and analyzing algorithm results.

Keywords: Critical success factors · Bosom cancer recognition · Machine learning · Fuzzy Mental Maps

1 Introduction

Bosom cancer is a kind of malicious tumor that affects bosom cells; the tumor can spread to the rest of the body; this disease globally affects women between the ages of 25 and 50; factors that indicate the increase or decrease of this disease include hormonal factors, genetic mutation, lifestyle, diet, overweight and environmental factors [1].

Over the past decade, the amount of bosom cancer has grown alarmingly as claimed by the global cancer research fund around 2 million new cases of bosom cancer were diagnosed in 2018 [2]; therefore, the study on the detection of bosom cancer has led to the increase in screening procedures and methods; today legitimacy has been demonstrated on certain hypotheses such as neural models [3], electromechanical devices [4], methods of joint learning [5], among others, however, the options presented so far about effective bosom cancer screening have their conditioning and limitation.

According to the Ministry of Public Health in Ecuador as of June 2018, 1287 new bosom cancer diagnostic were made, 1254 of these were from women representing a

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 874–881, 2022.
https://doi.org/10.1007/978-3-030-85540-6_111

rate of 97.6% of cases [6]. Imaging techniques are available for bosom analysis such as mammography, resonance, ultrasound, and biopsy; mammography is the most used in search of cancer characteristics [7].

2 Preliminaries

This segment presents the main theoretical references on the object of study, the different ideas that facilitate the understanding of the research are presented.

2.1 Machine Learning for Bosom Cancer Detection

Different authors have used machine learning in a wide variety of ways for detecting different types of cancer, however, this study aims to examine some related works to learn about their procedures and collect some main information that serves in the development of our article.

2.2 Fuzzy Mental Maps for Modeling Critical Success Factors

Fuzzy Mental Maps (FCM) enhance mental maps, describing the energy of the connection with the aid of using the usage of fuzzy numerical values withinside the [0, 1] or [−1, 1] [8]. FCM may be represented through a weighted directed graph wherein the nodes constitute thoughts and arcs suggest the presence of a causal relationship [9, 10]. An adjacency matrix is created from the values assigned to the arcs, the usage of fuzzy values [11].

I classical FCM have three styles of relationships amongst ideas [12]:

- Positive causality ($W_{ij} > 0$): Indicates a without delay proportional causal relation among two ideas C_i and C_j, that is, the increase (decrease) withinside the fee of Ci increases (decrease) withinside the fee of C_j.
- Negative causality ($W_{ij} < 0$): Indicates an inversely proportional causality among ideas C_i and C_j, that is, the increase (decrease) withinside the fee of Ci leads to the decrease (increase) withinside the fee of C_j.
- Non-existence of relationships ($W_{ij} = 0$): Indicates that doesn't exist causal courting among C_i and C_j.

When a collection of experts (k) participate, the adjacency matrix is formulated via an aggregation operator, in particular, the mathematics suggest or weighted mathematics suggest to suggest understanding or importance. For n experts, the adjacency matrix of the group FCM (E) is received as [12]:

$$\mathrm{E} = \frac{\sum_{i=1}^{n} \mathrm{E_i}}{\mathrm{n}} \tag{1}$$

This aggregation permits the advent of collective intellectual designs with extra reliability.

Centrality measures in FCM are calculated deliberating the importance of the weights Cij as follows [13]:

- Outdegree od(v_i) is received because of the sum of the rows withinside the adjacency matrix. It displays the power of the relations (c_{ij}) salient of the node.

$$od(v_i) = \sum_{i=1}^{N} c_{ij} \tag{2}$$

- Indegree id(v_i) is calculated because of the sum of the columns in fuzzy adjacency matrix and displays the Strength of the relations (c_{ij}) leaving the variable.

$$id(v_i) = \sum_{i=1}^{N} c_{ji} \tag{3}$$

- Centrality C_i s obtained from the sum of its indegree of input (id_i) and outdegree of output (od_i), as expressed in the following formula:

$$C_i = id_i + od_i \tag{4}$$

Centrality in an MCD indicates the importance of a node, built on their direct connections.

3 Material and Methods

The following is the framework proposed on this paper for the evaluation of the crucial achievement elements in bosom cancer recognition constructed on the machine learning algorithm (Fig. 1) [14]:

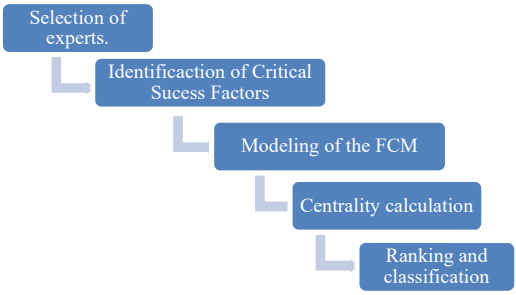


Fig. 1. Proposed framework

1. Selection of experts. The experts who participate in the identification of Critical Success Factors (CSF) and FCM are selected. This incorporation of multiple dimensions allows the achievement of the greater reliability of the design.
2. Identification of CSF: Critical success factors are identified built on the literature review and/or expert opinions.

3. Modeling of the FCM: The causal relationships between the CSFs are determined by assigning them a numerical value in the interval [−1, 1]. In the case of a group of experts participate adjacency matrix is formulated through the arithmetic mean operator Eq. 1.
4. Centrality calculation: The centrality measures are calculated and a composite centrality value is determined Eq. 4.
5. Ranking and classification: In this activity, the nodes are ordered in line with their significance withinside the design

The nodes are categorized in line with the following rules:

- Transmitting variables: variables with effective outdegree and zero indegrees.
- Receiving variables: variables with effective indegree and zero outdegree.
- Ordinary variables: variables with indegree and outdegree distinct from zero.

As software, a software tool FCMappers is used for calculation. FCMappers is a free, Microsoft Excel-built FCM analysis software; its goal is to minimize the time in the analysis and representation of mental maps; Additionally, a mental modeler tool is used to draw an analysis of FCM [15].

4 Case Study

A case study of the proposal was developed. According to the literature review. Three experts participated and thru analysis, expertise, and literature review. The following factors to implement an ML algorithm were identified:

- *Factor 1. Study of ML ideas and examples:* It is a necessary theory, evolution, uses, application areas, general architectures, benefits, and background; in addition to actual use cases and applications in the medical area.
- *Factor 2. Study of ML algorithms tested in bosom cancer:* Not all ML algorithms are applied to bosom cancer; it is necessary to review and verify that algorithms are used in the recognition of bosom cancer; through statistics to find out which has the highest accuracy.
- *Factor 3. Correct selection of ML algorithms:* Using a method or score for selecting algorithms objectively.
- *Factor 4. Selection of information set for training and testing:* First, you must determine the type of information you want to process; one type of information is images, another type is a text file; there are public places that contain cancer information with the aim of training and testing.
- *Factor 5. Selection of tools:* Depending on the type of information to be examined, you should look for tools or software applications to run ML algorithms; use, characteristic, benefits, execution times, and licensing are required; also consider the possibility that the software will run multiple ML algorithms in a single session to compare accuracy.
- *Factor 6. Performance analysis:* Analyze the performance of each algorithm to select according to the scenario or set the most appropriate ones.

- *Factor 7. Execution of ML algorithms:* According to hardware requirements, the number of iterations and volume of the information set the software takes its time in execution; the training and testing phase takes longer to process images.
- *Factor 8. Results Analysis:* To developed analyses of results through metrics like accuracy, sensitivity, and specificity values.
- *Factor 9. Selection of ML algorithm according to the results:* According to the articles read, accuracy is the best parameter to select an ML algorithm; the selected algorithm will be used for use in the following tests with actual information.

The FCMappers tool was used to apply critical factors and get the results of a mental map determined by experts. Figure 2 we present the weights assigned to the factors in a matrix, there are the numbers of the factors by space and understanding; factors are raised in a 9×9 matrix, where the values are set in rows and columns; this relationship between two factors Ci and C_j is the numeric weight C_{ij} between -1 and 1; if the weight is greater than 0, then it is a positive relationship; if the weight is less than 0, then it is a negative relationship; if the weight is equal to 0, then it's not a causal relationship.

	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5	FACTOR 6	FACTOR 7	FACTOR 8	FACTOR 9
FACTOR 1	0,00	0,27	0,39	0,00	0,00	0,00	0,00	0,00	0,00
FACTOR 2	0,00	0,00	0,77	0,00	0,00	0,00	0,00	0,00	0,00
FACTOR 3	0,00	0,00	0,00	0,42	0,53	0,00	0,61	0,00	0,00
FACTOR 4	0,00	0,00	0,00	0,00	0,00	0,00	0,75	0,00	0,00
FACTOR 5	0,00	0,00	0,00	0,00	0,00	0,48	0,00	0,00	0,00
FACTOR 6	0,00	0,00	0,00	0,00	0,00	0,00	0,42	0,00	0,00
FACTOR 7	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,67
FACTOR 8	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,79
FACTOR 9	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Fig. 2. Adjacency matrix.

For the analysis of the critical factors, in this case, we obtained from the FCMAppers software the outdegree, the Indegree, and the centrality of each factor; we rank the centrality in descending order (Table 1) to know the three most relevant factors that are: Factor 2 Study of ML algorithms tested in bosom cancer, Factor 6 Software selection for performance or benefits, and Factor 8 Obtaining and analyzing algorithm results; we deduct that factor 2, in the analysis/study of proven ML algorithms are important components that regulate the dynamics of the process, in addition, those involved in the project must give it a lot of emphases and know the correct algorithms for the recognition and detection of bosom cancer.

Factors that have high Outdegree values (Factor 9, Factor 7) have a strong or pressure on other factors in ML software execution; factors that have high Indegree values (Factor 6, Factor 3) are state variables and in this case, determine the selection of algorithms or ML software. Factors are classified in transmitting variables, receiving variables, and ordinary variables (Table 1).

Table 1. Centrality of factors.

Ideas	Outdegree	Indegree	Centrality	Classification
Factor 3	1.56	1.16	2.72	Ordinary
Factor 7	0.67	1.78	2.45	Ordinary
Factor 9	0.00	1.46	1.46	Receiver
Factor 4	0.75	0.42	1.17	Ordinary
Factor 2	0.77	0.27	1.04	Ordinary
Factor 5	0.48	0.53	1.01	Ordinary
Factor 6	0.42	0.48	0.90	Ordinary
Factor 8	0.79	0.00	0.79	Transmitter
Factor 1	0.66	0.00	0.66	Transmitter

In Fig. 3 the x-axis is the factors sorted in descending order according to the Centrality, the y-axis is the unit values to measure the Outdegree, Indegree, and Centrality; the blue bar is the Outdegree, the red bar is the Indegree, the green line is the Centrality (Fig. 4).

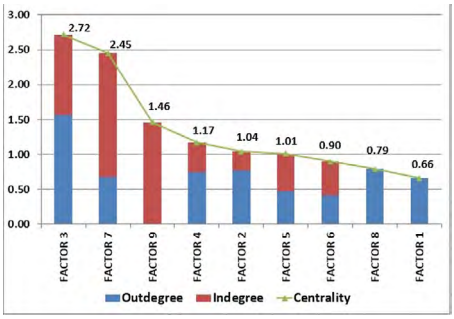


Fig. 3. Centrality indicators.

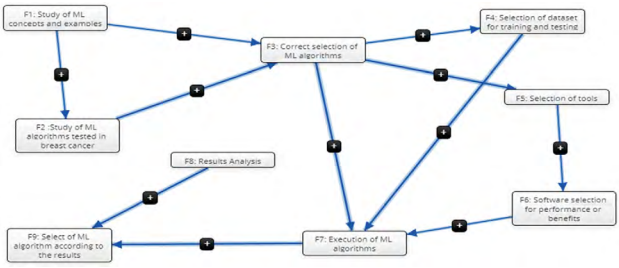


Fig. 4. The fuzzy mental relationship map

The factor with the most central is "Factor 3", which strongly influences many factors (Outdegree = 1.56) and is weakly influenced by other variables (Indegree = 1.16); the lower centrality factor is "Factor 1", although its indegree is small 0.00 and its outdegree is acceptable 0.66; factors that have the greatest influence over other factors (Outdegree > Indegree) are Factor 3, Factor 2, Factor 4, Factor 1 and Factor 8; factors with the highest indegree (Indegree > Outdegree) are Factor 7, Factor 9, Factor 5 and Factor 6. (Table 2) Overall the mental map design shows that the study and analysis of ML algorithms has a great influence.

Table 2. Factors with high Centrality, Indegree and Outdegree.

Centrality	Indegree	Outdegree
Factor 3: Correct selection of ML algorithms	Factor 3: Correct selection of ML algorithms	Factor 3: Correct selection of ML algorithms
Factor 7: Execution of ML algorithms	Factor 7: Execution of ML algorithms	Factor 2: Study of ML algorithms tested in bosom cancer
Factor 9: Selection of ML algorithm according to the results	Factor 9: Selection of ML algorithm according to the results	Factor 8: Results Analysis

5 Conclusions

In this paper, a structure for the analysis of critical success factors for the machine learning algorithm selection in bosom cancer recognition is presented. A case study is present to show the applicability of the proposal. In this case, the definition of critical success factors for selecting an ML algorithm was built on literature review and expert experience.

It was concluded that the critical factors for the selection of one or more ML algorithms in the recognition of bosom cancer are fundamental to achieve the project objectives; the mental map design shows that the study and analysis of ML algorithms has a great interdependence. Also, it was concluded that the more relevant critical factors for the selection of one or more ML algorithms in the recognition of bosom cancer are: the selection of an ML algorithm according to the results, the study of ML algorithms tested in bosom cancer, and obtaining and analyzing algorithm results.

The results obtained in our research can be a guide for the study and analysis of ML algorithms through mental maps. As future work, we propose an analysis and comparison of machine learning methods on bosom cancer information sets.

Acknowledgments. This work has been supported by the GIIAR research group and the Universidad Politécnica Salesiana.

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Geostatistical Method Used in Quarry-Type Exploitation Based on Gaussian Simulation to Reduce the Uncertainty of Hydrogeological Values in Surface Mining in Peru

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Abstract. In this article the application of a geostatistical method based on Gaussian simulation is studied to reduce the uncertainty of atypical data related to the hydrogeological data of a quarry, for which the data of the hydrogeological model of the impact study was considered as a basis environment of a quarry. This research proposes the application of Gaussian Simulation to identify the data that generate uncertainties in the elaboration of the hydrogeological model; such as the identification of underground aquifer levels. This technique first develops the verification of the hydrogeological data, then identifies the outliers, which will allow a better application of the Gaussian Simulation technique with the Gaussian algorithm to obtain a more reliable hydrogeological model. Finally, it is geostatistically demonstrated that the application of the Gaussian simulation reduced the uncertainty of the hydrogeological model by 20%.

Keywords: Hydrogeology · Gaussian simulation · Hydrogeological model · Slope stability

1 Introduction

Currently, in the mining activity, two major methods of mineral exploitation are being developed, the underground mining method and the surface exploitation method; In the latter, compliance with the regulations in various matters, fiscal, labor, health and social security must be reviewed and considered, also carrying out the Environmental Impact study, and presenting it for evaluation before the state and federal authorities in ecology and environment matters, who are in charge of establishing restoration, recovery, sustainability and maintenance measures to cushion the environmental impact of the extractive activity [1]. Statistics, broadest, world, region, local.

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 882–889, 2022.
https://doi.org/10.1007/978-3-030-85540-6_112

Likewise, it is important to maintain optimal slope stability and a reliable hydrogeological model, since the collapse of these slopes has historically caused human and economic losses, due to the time it takes to rebuild the affected area; in addition to an overload of the water table due to movement changes and the influx of groundwater [2]. The central zone of Peru is characterized by presenting more of these accidents with respect to others due to its regional geology. Importance of the problem, why do I consider distinctive factors, antecedents.

The motivation for this research is to reduce the uncertainty of the hydrogeological model using a geostatistical method based on Gaussian simulation, since in surface mining a reliable hydrogeological model is required to maintain slope stability and avoid accidents caused by them. Since before the open pit begins to be exploited, different studies are required, for example, a geomechanical, geological, hydrological and hydrogeological model. These need to be approved by different professional areas and for this, high reliability is required in these studies. In the case of the hydrogeological study, the study of piezometric levels in the mine is required, the slopes of which are mostly found with large concentrations of water. Therefore, it is worth having a method that solves the uncertainty problem in the hydrogeological model and thus obtain a more reliable model.

2 Estate of the Art

2.1 Geostatistical Method in Surface Mine

The use of a geostatistical method aims to construct realizations that reproduce the statistical properties of an underlying spatial random field in a shallow mine [1], such as its mean value, the variance and the spatial correlation measured by the variogram [2]. Also, obtaining accurate results is essential for the post-processing stage, where the realizations are used for spatial prediction and quantification of uncertainty [3]. Furthermore, the elimination of trend characteristics from the data is presented in a free way that explains the spatial structure and the multivariate relationship between the data and the trend [4]. For this reason, we want to propose a modified stepped conditional transformation for the geostatistical method [5].

2.2 Gaussian Simulation Model Using Geostatistical Method in Surface Mining

To test the inherent ability of the algorithm to reproduce the model statistics, the following strategy is used: Gaussian random values are simulated at the sampling locations, the Gaussian random field [6] is simulated at the target locations, the previous two steps they are repeated for each performance and the Student and Hotelling tests are performed to verify the reproduction of the mean, the variance and the variogram [7]. On the other hand, the steps for the stepwise conditional transformation using the Gaussian mixture model are the following : normal score transformation, review of the transformed

variables, multivariate density estimation and the cumulative distribution function of the trend does not enter any calculation [8], but the transformed data considers the trend at each location [9]. Conditional distributions are calculated using a Gaussian mixture model [10].

2.3 Quarry Type Exploitation Using Geostatistical Method in Surface Mining

The problems of the numerical simulations of the groundwater of a complex limestone formation quarry were developed in a conceptual model of the aquifer, based on extensive field work in situ and information analysis using Modflow [11], this simulation as steady state, as well as a first transient simulation. Furthermore, it presents a numerical model of groundwater flow in an open pit mine [12]. On the other hand, it is observed that, during the wet seasons, the bottom of the well is flooded because the groundwater flow exceeds the pumping capacity [13]. With increasing depths of the quarries, the problem worsens, potentially threatening the viability of the mine [14]. A more complete understanding of well dynamics was desired, leading the authors to create a numerical model of groundwater in the Visual Mod flow [15].

The combined evolution of various fields and related mining features in the complex hydrogeological environment in a quarry panel are analyzed in the data fields of overburden movement, aquifer water level change, and sprouting surface change [11]. Post Previously, the mechanism of a method is analyzed, which proposes a crack height model based on the vertical crack propagation criterion, and the mining parameters are modified to effectively reduce the impact of this method [12]. In this process, as high-level mining, a series of shafts are drilled vertically from the surface layer that covers the coal layer to observe the movement of the overloaded formation, the expansion of mining fractures and the behavior of water entry [13]. Likewise, an adequate drainage system is designed, so it is necessary to determine the source of water that enters the mine. During the extraction process, several wells drill a pressurized area to become mobile wells [14]. To study hydrogeology and provide a conceptual model of the study area, data from 15 manometers, 11 free-flow holes, and several exploratory holes are used. In addition, chemical sampling of the water is performed on the filter surface [15].

3 Input

3.1 Proposed Method

The proposed methodology considers the statistical analysis of the data from the hydrogeological model, as well as its transformation to Gaussian values and then pass that data to the SGeMS for the application of the Gaussian simulation, thus identifying the simulations with greater uncertainty and subsequently segregating them (Fig. 1).

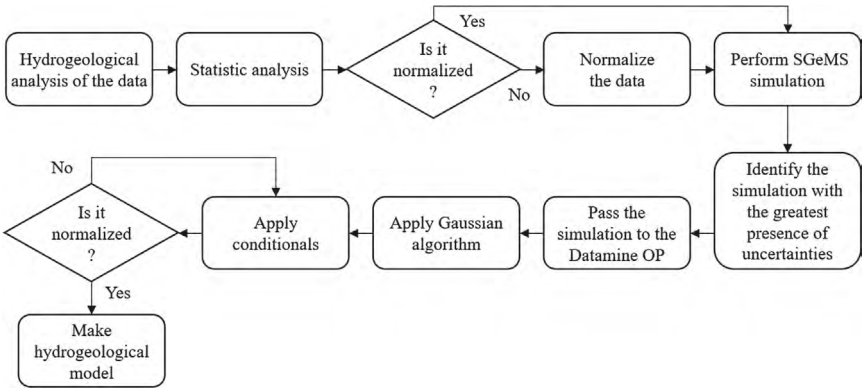


Fig. 1. Proposed methodology

3.2 Components of the Method

Phase 1: Hydrogeological Analysis. For the extraction of a metallic or non-metallic mineral, the hydrogeological evaluation must be carried out to avoid the collapse of the slopes in the exploitation phase and to control the study area. Given the uncertainty of not having a reliable model, it is proposed to evaluate the hydrogeological regime through the use of Gaussian Simulation, which will reduce the uncertainties of the hydrogeological data of the model. This method uses input data and simulated data to calculate variables, which generates many uncertainty options, which is why the greatest amount of data is required to analyze and complement the research carried out. In this way, the different models are focused on solving the great uncertainty and forecasting the movements of groundwater, as well as the exact verification in the use of the geostatistical technique.

Phase 2: Gaussian Simulation. The simulation can be refined by adding all available qualitative information on the actual demining phenomenon. For example, in the deposit, you can add the geometry of major faults, limit facies changes through earthquakes, and supplement knowledge of the physical properties of rocks through seismic attributes.

The simulation represents a numerical model of the reservoir, which is limited to the size of the smallest modeled structure. You can simulate sampling, sorting, mining transportation, mixing, and other methods. One of the great advantages of this technique is that they can be carried out with the only cost of calculation and computing (software and technicians), that is, it does not require a large investment in resources. For this, in the first place, a large data of the hydrogeological model was required that can be downloaded from the internet from a hydrogeological model. Second, this data must be converted to Gaussian values with the use of the Datamine Studio OP mining software. Once transformed to the Gaussian values, a geostatistical analysis is carried out through histograms and variograms in order to be able to establish whether it is a normal relationship and which part is the one with irregularities.

Third, after having analyzed and identified through geostatistics, this data is taken to the SGeMS software to simulate several models in which it is identified which of these simulations should be worked on in order to reduce uncertainties. Once the uncertainties

have been identified, these atypical data should be extracted that should not go and generate a new hydrogeological model without such a degree of error of uncertainties.

3.3 Indicators

As indicators of achievement we have, a database of drillings and piezometers in the quarry is required, as well as obtaining the corresponding mining software for each process that will be carried out in this investigation:

- The database of the hydrogeological model and the Gaussian values transformed with the use of the Datamine software.
- The table with the tabulated data in Excel identifying the outliers through the statistical and geostatistical analysis of the hydrogeological values of the model.
- The Gaussian algorithm with the data obtained from the histograms for the simulation of the hydrogeological parameters.
- Atypical results that will be obtained after running the Gaussian Simulation.
- Improvement methods to carry out the hydrogeological model and to make it more reliable.

4 Validation

4.1 Verification of the Hydrogeological Data of the Quarry and Adapt Them to the Gaussian Values Method

The hydrogeological database is obtained from the environmental impact study of the quarry. These data, which were originally in a notepad, will be tabulated in an Excel sheet in order to keep the data in order. Once the database is tabulated in Excel, the file will be saved in csv format. After this, the Datamine Studio OP software will open, which is capable of carrying out open pit mining projects. In the mining software, we select the option "New Project" which is at the beginning of the program, from there a window will open, in which two fields appear that we must fill, the first is "Name" (name of the project that will work) and the second field is "Location" (location where the project will be saved). Once these fields have been filled in, the "next" option will be selected 2 times and then "finish". With this, the project to be worked with will be created. In the same way, select the "Project Files" tab in which the project that was created previously will appear, right click on the project, and the option "import data" will appear.

Once the Data Import window is configured as shown in the figure, the "OK" button will be selected, this will open another window in which the csv file that was previously saved must be selected and the "accept" option is selected. Finally, another window will open that consists of 3 steps: first the option "Delimited" will be marked and then "next", the second step is to mark the option "Commas" and "next", the third step is to select the button "Finish" two more times and a new file will be generated in the folder where the project was saved.

4.2 Identification of Outliers and Acceptable Statistical Results for the Hydrogeological Model

After transforming the hydrogeological values obtained from the database to Gaussian values by means of the Datamine Studio OP software, the following steps will be carried out to generate histograms with the help of the same software. First of all, you must have the file correctly created with the Gaussian values. Second, to create histograms, the "Report" tab must be checked, which is located on the top bar of the program. Once in the "Report" tab, click on the "Histogram" option, with this, the window will appear in which the histogram to be obtained will be generated. In this new window, the option "Data File" will be marked and another window will open in which the file with the extension ".dm" that was created in the previous specific objective will be selected. You will configure what kind of histogram will be required, it can be an incremental normal/log normal histogram, or a cumulative normal/log normal histogram. The "Apply" button will be clicked and the histogram will be generated. In this histogram, the statistics of all the Gaussian values obtained can be obtained in the "Statistics" tab, such as the number of values, the mean, the variance. In addition, it will be possible to verify which are the atypical values, and will proceed to eliminate these values manually in the database itself.

4.3 Development of the Gaussian Simulation Technique with the Gaussian Algorithm

After having identified the atypical values in the hydrogeological model database and having analyzed the histogram that was generated thanks to the statistics of these data, it will be obtained that the mean is less than the variance, the Gaussian Simulation will be carried out applying the Gauss algorithm. To apply this algorithm, it must be carried out in the SGeMS software, in which, with the data that is in "csv" format, it must be imported for the new project. Then, you will have to go to the "Algorithms" option, then the "Simulation" option is selected, which will display several simulation options, among which there is the Gaussian Sequential Simulation, the "sgsim" option will be selected. Once this option has been made, we will proceed to configure the other fields, in which the "csv" file that was imported as data will be indicated, as well as the number of realizations that will be executed and the type of kriging, for this case it will be selected the "OK (Ordinary Kriging)". Click on the "load" option to execute the realizations (simulations), on the "save" option if the project will be saved or on "clear all" to delete everything and start with other simulations.

4.4 Segregation of Outliers that Generate Uncertainty in the Development of the Hydrogeological Model of the Quarry

Once the simulations have been applied with the help of the Gaussian algorithm in the SGeMS software, it will be possible to identify holes in the simulations, which are indications that the simulations of the hydrogeological models were not carried out correctly and will present a high degree of uncertainty between their data. numerical. For which, these simulations in ".dm" format will be taken to the Datamine Studio OP

mining software, to segregate the outliers found previously. We will proceed to open the project that was created previously and in the folder the files with the extension ".dm" will be pasted, for which we refresh in the "Project Files" tab and these added files will appear. After obtaining these files, it will go to the command bar to place the "extra" process, in which it will allow us to eliminate these erratic highs found in the data. A new window of the "Extra" process will open in which the ".dm" file of the simulations will be loaded as the input file and a name will be given to the output file that will be generated. Click on "ok" and another window will open in which you will have to write certain conditionals to eliminate erratic highs, "0" values and missing values. These conditionals will be:

"IF (DRAINS = = 0.0) ---- Deleted () END"
"IF (DRAINS = = Absent () ---- Deleted () END"

This same sequence for all the other fields in which these atypical values are present, once all the conditions have been entered for all the fields, the "Run" option will be clicked to execute these commands to segregate these values.

4.5 Proposal of Improvement Guidelines in the Hydrogeological Model of the Quarry

Once the "extra" process is carried out in the Datamine Studio OP software, an output file will be obtained with the new data, free of these outliers, that is, with less uncertainty between your data. Subsequently, improvement guidelines will be proposed to obtain better data with a lower degree of uncertainty. For which, the conditionals that were used to execute the "extra" process to segregate these outliers in the original data must be disclosed. Then the option will be raised of having more data with more information that complements the hydrogeological model of the mine as a whole and not of a specific area so that with more data, the greater the precision with which the hydrogeological model will be carried out and identify the presence of water in key areas in the rock massif in which the mine is operating.

5 Conclusions

The hydrogeological model database was obtained through the environmental impact study of a quarry, which allowed to achieve the objectives of the present investigation. In addition, the efficiency of the Gaussian Simulation could be verified to reduce uncertainties in the hydrogeological model database.

Thanks to the geostatistical analysis of the data transformed to Gaussian values, it was possible to perform the histogram where it was possible to verify that there is a section in which there are atypical values (uncertainties) of the hydrogeological modeling, being observed in the histogram that does not present a normal trend, on the contrary, it presents certain irregularities.

The use of the Gaussian Simulation allowed to carry out several simulations necessary to identify in which of them the Gaussian algorithm was applied and to be able to

reduce the uncertainties in relation to the hydrogeological data, in order to obtain a more reliable model.

It was possible to reduce the uncertainties, by means of the simulation, by approximately 20%, related to the atypical values, which allowed a better evaluation and construction of the quarry slopes.

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A Machine Learning Model Comparison and Selection Framework for Software Defect Prediction Using VIKOR

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Abstract. In today's time, software quality assurance is the most essential and costly set of activities during software development in the information technology (IT) industries. Finding defects in system modules has always been one of the most relevant problems in software engineering, leading to increased costs and reduced confidence in the product, resulting in dissatisfaction with customer requirements. Therefore, to provide and deliver an efficient software product with as few defects as possible on time and of good quality, it is necessary to use machine learning techniques and models, such as supervised learning to accurately classify and predict defects in each of the software development life cycle (SDLC) phases before delivering a software product to the customer. The main objective is to evaluate the performance of different machine learning models in software defect prediction applied to 4 NASA datasets, such as CM1, JM1, KC1, and PC1, then de-terminate and select the best performing model using the MCDM: VIKOR multi-criteria decision-making method.

Keywords: Machine learning · NASA dataset · Software defect prediction · VIKOR method · MCDM

1 Introduction

Currently, there is a great interest in the standardization of quality assurance due to the increasing demand for high-quality software products. Software quality assurance, the most critical and costly set of actions during planning, analysis, design, implementation, testing, integration, and maintenance within SDLC (Software Development Life Cycle), plays a fundamental pillar in information technology (IT) industries for the main reason of anticipating defects before they occur [1]. However, finding and reducing the number of defects is one of the biggest problems in today's software development lifecycle due to various factors such as time and workforce constraints. At the time of testing, the software product may have thousands of defective modules, which turns out to be very tedious and costly in allocating both financial and human resources to thoroughly review and predict these defects [2].

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 890–898, 2022.
https://doi.org/10.1007/978-3-030-85540-6_113

Therefore, to provide and deliver a reliable software product with as few defects as possible in an agreed time and of good quality, most studies have employed machine learning techniques and models, such as the supervised learning approach to accurately classify and predict defect-prone software modules at different stages of the software development process before delivering a software product to the customer [3]. Supervised learning models work with data labeled in the wrong or non-faulty category; their processes consist of two stages: training stage and testing stage [4]. For some time now, researchers have been working on different techniques and models based on machine learning (supervised – unsupervised) [5]. However, there is still no predefined model that is well suited to all data classification and prediction problems. Accordingly, problems arise in deciding the selection of a model that is efficient and has the best performance. It can be modeled as if it were an MCDM (Multiple Criteria Decision Making) problems because the evaluation of models usually has more than one performance measure, and to solve this problem, the VIKOR method is applied [6].

This paper aims to evaluate the quality and performance of supervised machine learning models in software defect prediction and determine the best performing model by comparing six machine learning models using different quality assessment metrics. It was applied in the scope of four public NASA datasets. The machine learning models selected for evaluation and comparison are as follows: (i) Naïve Bayes (NB), (ii) k-Nearest Neighbor (kNN), (iii) Random Forests (RF), (iv) Logistic Regression (LR), (v) Support Vector Machine (SVM), (vi) Neural Networks (NN), which in previous studies have shown high performance. Next, the MCDM: VIKOR method to determine the different models' results as input to systematically select the appropriate model that will classify and predict future software defects. The rest of the organization of this article consists of: Sect. 2 provides preliminaries. Section 3 describes the MCDM: VIKOR. Section 4 specifies the case study and shows the results. The last section presents the conclusion and future work.

2 Preliminaries

This section briefly describes each of the essential elements of the research work, a brief overview of each of the supervised machine learning models employed, and the metrics for performance evaluation.

2.1 Machine Learning (ML) Models

A brief description of several different fundamental self-learning supervised classification models used for statistical data analysis and software defect prediction is presented [7]. Among the main classifiers, the following are used: NB is a very accessible model to implement. It is based on Bayes' theorem. It assumes that the probability of an attribute in a class does not depend on other features. RF is an exceptional model of an independent collection of trees. They combine different decision trees from a random sample training process. Each tree gets a different classification result; the best solution is obtained by the most significant number of classification votes in the whole forest. SVM is an ideal line model (a hyperplane) that perfectly separates into two distinct groups by maximizing

the margin defined as the perpendicular distance between the support vectors' decision boundaries where each class is placed on each side [8]. NN is a network model whose structure resembles the brain's neural connections, using the multilayer perceptron algorithm with backpropagation consisting of an input layer, an output layer, and at least one or more masked layers [9]. kNN is an intuitive model for classifying new instances in the same class based on the similarity (Euclidean distance) of existing cases, looking within a dataset for the "most similar" patterns. LR is a binary classification statistical model whose function estimates the ratio between the dependent variable and one or more ordinal, nominal, or interval independent variables [10].

2.2 Performance Evaluation Metrics

To assess the machine learning models' performance above, several commonly used evaluation metrics are broadly used in every software defect classification and prediction task [11]. To calculate the values of the metrics, and this helps to visualize and analyze the performance of each trained model, a tool called confusion matrix is applied [12, 13]. Table 1 shows the description and respective formula for each metric.

Table 1. Performance evaluation metrics

Metrics	Description	Function
Accuracy (A)	% of instances that are correctly classified out of the total number of classifications	$A = \frac{TP+TN}{TP+TN+FP+FN}$
Specificity (S)	% of negative instances correctly classified among all actual negative classifications	$S = \frac{TN}{TN+FP}$
Precision (P)	% of positive cases correctly classified out of the total number of cases positively classified	$P = \frac{TP}{TP+FP}$
Recall (R)	% of positive instances correctly classified out of all actual positive classifications	$R = \frac{TP}{TP+FN}$
F-Measure (FM)	% of weighted harmonic mean between precision measurement and recall measurement	$FM = 2 \cdot \frac{P \cdot R}{P+R}$

3 MCDM Method: VIKOR

MCDM methods (i.e. multi-criteria decision making) are powerful tools, which consist of mathematical algorithms by taking as inputs: the alternatives, the criteria, and their weight [14]. They have become increasingly helpful in many fields, helping to solve structural problems. There are several MCDM methods. In this section a typical MCDM method is presented as VIKOR (i.e., Multidisciplinary Optimization and Trade-off Solution): it was created by Yu and Zeleny and later supported by Opricovic and Tzeng. This method ranks some alternatives based on conflicting criteria to determine a compromise solution close to the ideal solution [15, 16]. The steps to follow are:

Step 1. Establish the decision matrix and determine the ideal positive and negative solution: the best ones f_j^+ and the worst f_j^- values of each of the criterion functions.

$$f_j^+ = Max_i f_{ij}, \quad f_j^- = Min_i f_{ij}; j = 1, 2, \ldots, n \text{ if the criterion is profit} \tag{1}$$

$$f_j^+ = Min_i f_{ij}, \quad f_j^- = Max_i f_{ij}; j = 1, 2, \ldots, n \text{ if the criterion is cost} \tag{2}$$

Step 2. Calculate the group utility measures and individual measures of regret associated with each alternative, respectively, where S_i and R_i represent the utility and regret measures, are computed as follows. Where w_j means the weight of the criteria.

$$S_i = \sum_{j=1}^{n} w_j \frac{\left(f_j^+ - f_{ij}\right)}{\left(f_j^+ - f_j^-\right)} \tag{3}$$

$$R_i = Max_j \left[w_j \frac{\left(f_j^+ - f_{ij}\right)}{\left(f_j^+ - f_j^-\right)} \right] \tag{4}$$

Step 3. Calculate the values of the Q_i index: The Q_i index is found for each alternative.

$$Q_i = \gamma \frac{(S_i - S^+)}{(S^- - S^+)} + (1 - \gamma) \frac{\left(R_i - R^+\right)}{\left(R^- - R^+\right)} \tag{5}$$

Where: $S^+ = Min_i\{S_i\}$; $S^- = Max_i\{S_i\}$; $R^+ = Min_i\{R_i\}$; $R^- = Max_i\{R_i\}$ and γ refers to the weight of the group's maximum profit strategy represented by the value 0.5.

Step 4. Ranking the alternatives in decreasing order, we obtain three ranking lists by values S_i, R_i, Q_i.

Step 5. Propose alternative $A^{(1)}$ as the tradeoff solution which is the highest ranked by Q (i.e., minimum Q), if it satisfies both of the following cases:

a) Case 1 - Acceptable advantage: $Q(A^{(2)}) - Q(A^{(1)}) \geq (1/(\mathrm{m} - 1))$; m is the number of alternatives.
b) Case 2 - Acceptable stability where the alternative $A^{(1)}$ in addition to being better at Q, would also have to be the highest ranked in the lists S y/o R.

A set of compromise solutions is proposed if either of the 2 cases is not fulfilled:

- Alternative $A^{(1)}$ and $A^{(2)}$, only if case 2 is not met.
- Alternative $A^{(1)}$ and $A^{(2)}$,…, $A^{(M)}$, only if case 1 is not satisfied. The maximum M can be determined by $Q(A^{(M)}) - Q(A^{(1)} < (1/(\mathrm{m} - 1))$;

4 Empirical Case Study

In this study, NASA public datasets, available online in the PROMISE repository, were used, initiated by the University of Ottawa to create predictive models of defects in software systems [17]. The NASA datasets contain 22 attributes of the 4 McCabe metrics, 9 Halstead base metrics, 8 Halstead derived metrics, and finally the target attribute, metrics and metrics are extracted from the source code. During the experiments, public datasets known as CM1, JM1, KC1 and PC1 were used [18, 19]: Dataset CM1 included 498 modules with 9.83% of defects developed with C language, called space tool. Dataset JM1 included 10885 modules with 19.35% of defects developed with C language, called terrestrial prediction system. Dataset KC1 included 2109 modules with 15.45% of defects developed with C++ language, called storage management for receiving and processing terrestrial data. Dataset PC1 included 1109 modules with 6.94% of defects developed with the C language, called flight designed for satellites in Earth orbit [20].

The k-Fold cross-validation was used to train, test and validate each proposed model. The value of k is determined as 10, where the data sets are divided into 10, each iteration are randomly. To train the model, 9 of the 10 parts are used, the residual part is retained for testing. After 10 iterations, the average of the evaluation metrics is taken as the final result on each machine learning model and each dataset, as shown below. The experimentation was performed on the usual use of the widget (Orange Data Mining) on an Intel© Core™ i5-9500 CPU at 3.40 GHz with 16 GB of DDR4 RAM.

4.1 Results

4.1.1 Evaluation Results

Based on the evaluation by cross-validation with the different performance measures to the machine learning models, the results obtained are shown in the following tables. Table 2 shows the results of the evaluation of the NB and kNN models, these performance scores on each dataset (CM1, JM1, KC1, PC1) are averaged.

Table 2. Results of the evaluation of the NB and kNN models

Dataset	NB					kNN				
	A	P	R	S	FM	A	P	R	S	FM
CM1	0,633	0,882	0,633	0,742	0,707	0,884	0,811	0,884	0,096	0,846
JM1	0,709	0,756	0,709	0,531	0,728	0,789	0,748	0,789	0,346	0,760
KC1	0,718	0,835	0,718	0,705	0,754	0,836	0,807	0,836	0,353	0,816
PC1	0,699	0,903	0,699	0,617	0,772	0,931	0,909	0,931	0,166	0,909
Avg.	**0,690**	**0,844**	**0,690**	**0,649**	**0,740**	**0,860**	**0,819**	**0,860**	**0,240**	**0,833**

Table 3 shows the results of the evaluation of the RF and SVM models, these performance scores in each data set (CM1, JM1, KC1, PC1) are averaged.

Table 3. Results of the evaluation of the RF and SVM models

Dataset	RF					SVM				
	A	P	R	S	FM	A	P	R	S	FM
CM1	0,888	0,844	0,888	0,170	0,860	0,582	0,848	0,582	0,573	0,666
JM1	0,812	0,781	0,812	0,388	0,785	0,317	0,684	0,317	0,677	0,322
KC1	0,857	0,835	0,857	0,412	0,839	0,355	0,774	0,355	0,724	0,395
PC1	0,932	0,916	0,932	0,286	0,909	0,509	0,884	0,509	0,591	0,620
Avg.	**0,872**	**0,844**	**0,872**	**0,314**	**0,848**	**0,441**	**0,798**	**0,441**	**0,641**	**0,501**

Table 4 shows the evaluation of the LR and NN models, these performance scores in each data set (CM1, JM1, KC1, PC1) are averaged.

Table 4. Results of the evaluation of the LR and NN models

Dataset	LR					NN				
	A	P	R	S	FM	A	P	R	S	FM
CM1	0,892	0,848	0,892	0,170	0,862	0,882	0,843	0,882	0,187	0,858
JM1	0,807	0,756	0,807	0,260	0,747	0,809	0,775	0,809	0,378	0,780
KC1	0,852	0,833	0,852	0,327	0,827	0,855	0,838	0,855	0,410	0,838
PC1	0,931	0,911	0,931	0,214	0,914	0,923	0,899	0,923	0,201	0,907
Avg.	**0,871**	**0,837**	**0,871**	**0,243**	**0,838**	**0,867**	**0,839**	**0,867**	**0,294**	**0,846**

At first glance, the NB and SVM models show low yields compared to the other models, while the k-NN, RF, LR, and NN models show approximately similar high yields.

4.1.2 VIKOR Results

The evaluation results are used as input data to benchmark and make the selection of the best alternative using the VIKOR method. The decision matrix a × b (6 × 5) where a alternatives Ai, i = 1, 2…, m (i.e., A1 is "NB". A2 is "kNN". A3 is "RF', A4 is "SVM" and A5 is "LR", A6 is "NN") and b criteria Cj, j = 1, 2…, n (i.e., C1 is "A". C2 is "P". C3 is "R", C4 is "S" and C5 is "FM"), criterion C4 is considered cost, the other criteria are considered to benefit.

The best f_j^+ and worst f_j^- are then determined using formulas (1) and (2), as illustrated in Table 5.

Table 5. Decision and value matrix $f_j^+ - f_j^+$

	C_1	C_2	C_3	C_4	C_5
A^1	0,690	0,844	0,690	0,649	0,740
A^2	0,860	0,819	0,860	0,240	0,833
A^3	0,872	0,844	0,872	0,300	0,848
A^4	0,441	0,798	0,441	0,641	0,501
A^5	0,871	0,837	0,871	0,243	0,838
A^6	0,867	0,839	0,867	0,294	0,846
f_j^+	0,872	0,844	0,872	0,240	0,848
f_j^-	0,441	0,798	0,441	0,649	0,501

The values of the regret measure R and utility S are calculated by incorporating the weight equally for each criterion. With these values, the vikor index Q is calculated according to formulas (3) to (4), the result is shown in Table 6.

Table 6. The values S, R, and Q

	S	R	Q
A^1	0,431	0,200	0,708
A^2	0,129	0,109	0,288
A^3	0,029	0,029	0,009
A^4	0,996	0,200	1,000
A^5	0,039	0,030	0,016
A^6	0,055	0,026	0,013

Table 7 below presents the ranking list of the alternatives based on the values of the utility measure S, regret R, and vikor index Q.

Table 7. Ranking of alternatives based on the values of S, R, and Q.

	Rank in S	Rank in R	Rank in Q
A^1	5	5	5
A^2	4	4	4
A^3	1	2	1
A^4	6	6	6
A^5	2	3	3
A^6	3	1	2

Case 1 not being fulfilled, the compromise solution sets are alternatives 3, 6, 5, are selected as the final alternatives. Then, the ranking order of the six machine learning models concerning the five evaluation criteria is A3 ≻ A6 ≻ A5 ≻ A2 ≻ A1 ≻ A4. RF performs better than the other proposed models since it is closer to the value 0. While SVM presented the lowest performance than the other models since it is closer to the value 1.

5 Conclusion and Future Work

Based on the work performed and presented, it was concluded that nowadays machine learning models are very necessary to predict and prevent defects in software systems before they are delivered to the customer. Therefore, six machine learning models were evaluated with different performance measures applied to each of the proposed datasets (CM1, JM1, KC1, PC1), where it was observed that the k-NN, RF, LR and NN models show high and approx. similar performances, while the NB and SVM models show low performances. However, determining and selecting the model with the best performance becomes a complicated task, since the models involve more than one performance measure and their results are similar, so it is convenient to model them as a multiple criteria decision making (MCDM) problem. The VIKOR method allows to classify and select the most appropriate model in a simple and structured way, where the RF model was the best classified, with the best capacity in predicting software defects. As a guideline for future work, other machine learning models can be used with other defect datasets currently available online in the PROMISE repository.

Acknowledgments. This work has been supported by the GIIAR research group and the Universidad Politécnica Salesiana.

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Predictive Model Influenced by External Factors to Reduce Uncertainty in the Budget Forecast of a Gold Mining Company

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Abstract. In this research we propose to apply the qualitative evaluation technique by points to the factors that influence the price of gold. In addition, we will simulate the context of 2015, a year in which the price of gold reached historical lows, and at the same time, a period in which the analyzed company was going through a period of crisis when seeing that its valuation was affected by the devaluation of its reserves and growth of debts with suppliers. The research was carried out for the forecast of the price of gold, the general budget of the company, the budget in the mine operations area and the budget of the plant operations area, but for reasons of space in the development of the paper we will only show the development with the price of gold and the area of operations in the process plant.

Keywords: Control · Budgets · Forecasts · Commodity prices · Trend lines

1 Introduction

Metal prices have shown a high level of price volatility in the last three decades. The mining industry is the most susceptible to these changes due to its metal production. Today, it is inevitable to coexist with mining as this extractive activity is the product of human evolution throughout its history. Since time immemorial, human beings have valued minerals, specifically metals, to monetize transactions or wear garments such as jewelry and wealth. By the time we transfer that demand that has been growing over the centuries, it is necessary to start mining megaprojects. Therefore, the NO to mining is absurd.

The mining industry in Peru accounted for 60.9% of exports in 2019; likewise, in the same year the metallic mining represented 9.06% of GDP. The markets of raw materials or commodities such as the London Metal Exchange (LME) in the face of a geopolitical or economic event vary their metal prices. By concept of the investigation it is necessary to understand this investigation the context of the year 2015, in which the price of gold

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 899–906, 2022.
https://doi.org/10.1007/978-3-030-85540-6_114

fell to the value of USD/Ounce 1100 at the end of 2015 having been at the beginning of that year to USD/Ounce 1350. This It was caused by the stabilization of the real estate bubbles of 2008. In addition, the United States stopped buying assets and set low fixed interest rates which affected the demand for gold, at the same time, other investors observed that maintaining a high price of gold. Gold was unnecessary for that time. Let us remember that gold is a metal that serves as an investment refuge in times of crisis.

To reduce the uncertainty of the methodology applied to generate Forecasts, in this research the application of trend lines will be evaluated and they will be subjected to the influence of external agents through the qualitative methodology by points. The research evaluates the uncertainty that is handled in the forecast of gold prices, in addition to the budget applied to the plant area.

2 Estate of the Art

2.1 Predictive Models in Gold Mining

Since time immemorial, very ancient civilizations such as the Romans and later the Spanish in the colony, knew the definition of budget as the cost necessary to assume the expenses in the realization of a work. Thus, when evaluating the viability of a physical work or project, the generation of a budget is essential.

But the formulation of the project is not where the greatest difficulty arises, it will arise when you want to translate the project into reality and execute it. As Fernando Valdez tells us, in his article Strategic Management in times of crisis [1, 2]. He tells us that less than 10% of the strategies effectively formulated are actually executed and that in 70% of the cases it is predicted that the real problem of the project is not in its formulation but in its execution [1, 3].

Fernando Valdez in his article "strategic mining management in times of crisis" describes a tangible problem: the management of the Budget for the execution of a business strategy in times of crisis, of course he mentions specific characteristics of the company, but if we give it a general approach, it is not the only company that suffers from these problems [3, 4]. He proposes that Budget control will be managed with the help of the Forecasting application as a situation estimation methodology with qualitative and quantitative data. As a result, after applying the Forecast to the budget management problem, the results he obtained were positive. About 95% reached the objectives of the strategy, in the time allocated to develop it, it was possible to avoid problems or setbacks in the development and application of the strategy due to the detection of problems with the forecasting method applied to business. The budget is affected by poor initial analysis, poor risk assessment, poor management, the effects of external agents, and political changes.

2.2 Budgeting in Mining

To evaluate the influence of qualitative over quantitative methods, one of the common techniques is the Brown & Gibson methodology, which turns perceptions into something measurable. These should influence the major and minor Forecast models [5] based on this knowledge, it is validated that the forecast methodology is already applied to estimate sales, generate budgets and cash flows through the analysis of probabilities and correlations [6]. It is necessary to elaborate the forecasts, but without rejecting the assumptions that could be generated and for that the forecast methodology includes the What if technique which is simple and describes the ability to form assumptions based on personal criteria in relation to things that can be face in the future. This is necessary because it allows us to achieve a greater benefit in the face of circumstantial opportunities that may be presented to us. And in the mining industry, which is where large amounts of money are handled, it is crucial to take advantage of them [7, 8].

The practical analytical method of Monte Carlo commonly used to predict budgets together with the zero-based method have not shown the necessary certainty for the moments of crisis that this mining company faced. But in times of high price volatility it is understandable that the budgets are not very exact [3, 9] it is where the qualitative method by points that has been basic in the evaluation of projects due to its simplicity comes to notice its importance. The prices govern the viability of the budgets, if these are very low and the costs do not ensure a profit then the project does not go, but if the prices remain high and the budgets low that ensure the continuity of the operation in times of crisis, That is where we see that the independent variable is the price of mineral which demands how the operation is going to be executed but this responds to the influence of qualitative data from the environment, that is, a political and economic decision, a blockade of countries, the rise of the derivative producer of a certain metal, etc. They are going to have an impact on prices and consequently on budgets. A tool to make the qualitative to quantitative is the point valuation method which we will apply to find a variation in the forecasts and compare them with the real ones and those projected by the company [10, 11].

3 Input

The elaboration of the Budget in the mining industry is very important to achieve the goals proposed for the fiscal year. In addition, it is through the application of the budget that the necessary value is generated for the investor, as well as being the objective of every company. The budgeting process is affected in times when uncertainty about the international market context is high.

For the process known as Budgeting in mining companies, some commonly applied methodologies are defined: Monte Carlo, a quantitative data forecasting method that recognizes internal cycles and acts based on assumptions. Six Sigma, a Lean methodology applied to budget execution and optimization. Zero Base, is a comparative budget model applied to the generation and control of the budget. They are models that are part of a set used by managers to prepare the Budget.

The previously described models are applied in the mining industry for the effectiveness in the forecasts and control of the Budget in times of low speculation on the price. The negative of the exposed models is the uncertainty in periods of high speculation about the prices of commodities in the international market. For which the application of predictive models based on the valuation of points to external agents directly related to the price of the mineral and to agents related to the company's strategy on the budgets of each area and the general budget is proposed.

The prices of commodities in the international market move in base to the level of speculations that generate geopolitical and social events, actions of international governmental entities, economic blockades, fall in the value of the US dollar or the rise the value of the US reserve bank interest rate. The process begins with the generation of quantitative forecasts with the help of trend lines on the historical price. Then we will select based on an analysis of international events, decisions, strategies, etc. Those we assume have a direct influence on commodity prices and company budgets. We will apply the model of quantifying the qualitative data with the qualitative methodology by points and the values will influence them on the quantitative forecasts generated by trend lines. In addition, we will follow the "On Going" rhythm which expresses the generation of the Forecast and modification of the forecasts at the rate that updated data on the budget or price are added.

The indicators that will be handled are the intervals in which the price variation is handled. Through the generation of tables with the monthly forecasts in the crisis of the year 2012–2016 on the price of gold in the international market. Generating forecasts based on 36–60 months of historical data plus the influence of qualitative data. In addition to graphs where the variation of the forecasts is compared with the methodology of this research, against the forecasts prepared by the company with other models, and these against the real values executed for the first months of 2016.

The following flow chart demonstrates the detailed procedure of the variation in the applied methodology, in which qualitative data are used and through the qualitative point technique we convert them into quantitative data (Fig. 1).

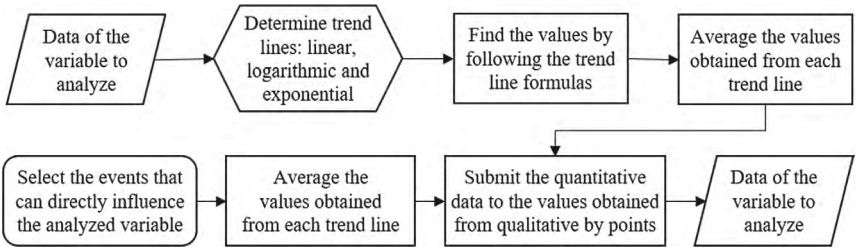


Fig. 1. Flow chart of the proposed technique.

4 Validation

Gold prices were obtained from the Kitco.com historical database from January 2011 to December 2017. As the authors explain, it takes 36 to 60 months of historical data to

make an acceptable estimate of the price of commodities, this time, the metal analyzed will be Gold, a metal known as Precious metal and much longed for since pre-Inca times, through the colony and the republic, today the largest gold reserves are found in the United States, specifically in its reserve bank. Which we will see later that greatly influences price speculations. Another fact that we must know about gold is that it is considered a safe haven metal, it acts as an investment asset in epoas where speculations on the markets or world economic status are unstable and high. One quality that gold possesses is that its rises are fast but its falls are slow. Taking this data of the price of gold over time, the line graphs were generated. In order to obtain the trend lines that the price owns. Note for a clear revision of the historical prices in the table of gold prices from January 2011 to December 2015, there is already a notable tendency to the price drop. From 2011 to 2015 there was a fall in the price of gold in which it touched historical minimum levels. After the great recession that hit the US in 2008, investors, seeing better investment environments, decided to withdraw their investments housed in gold for more than 3 years, in addition to the fact that the US Treasury raised the interest rate, which did that many investors, switch from gold to bonds that gives the government, the world economy was recovering from a severe blow.

Data on the price of gold in the international market were collected. Then the data base of the results of costs applied to the Aurifera mining company in 2015 by specific areas was taken.

Then, the concepts that make up the general budget of the mining company and the participation percentages of each specific concept were analyzed, in order to achieve an average behavior of the budget and its distribution. The largest expenditures being those represented by the mine area, followed by plant, these areas were the object of research, in this paper we will discuss the development of the methodology analysis in the general budget of the company and its behavior during a crisis gold in 2016 and the application of the Forecast methodology with the On Going rhythm.

After analyzing the forecasts following the trend lines, they were prepared by simulating the on-going rhythm, so we will observe that it changes over time (Fig. 2).

Evolution of the TOTAL budget with trend lines						
DEC	JAN	FEB	MAR	APR	MAY	JUN
$ 2,814,809	$ 2,368,715	$ 2,337,048	$ 2,305,920	$ 2,275,282	$ 2,245,097	$ 2,215,330
$ 2,814,809	$ 3,287,803	$ 2,569,012	$ 2,558,645	$ 2,548,446	$ 2,538,399	$ 2,528,487
$ 2,814,809	$ 3,287,803	$ 3,204,371	$ 2,711,222	$ 2,714,054	$ 2,716,930	$ 2,719,844
$ 2,814,809	$ 3,287,803	$ 3,204,371	$ 3,162,061	$ 2,813,324	$ 2,824,262	$ 2,835,209
$ 2,814,809	$ 3,287,803	$ 3,204,371	$ 3,162,061	$ 4,101,455	$ 3,087,140	$ 3,118,761
$ 2,814,809	$ 3,287,803	$ 3,204,371	$ 3,162,061	$ 4,101,455	$ 3,982,613	$ 3,288,701

Fig. 2. Application of trend lines in forecasts.

Subsequently, the qualitative influence table was drawn up, in this case they would correspond to some internal agents of the company because they correspond to the strategy that the company's senior management decides to adopt to overcome the crisis (Table 1).

Table 1. Technique for evaluating qualitative points for the general budget of the company.

For the general budget			
Aspects of the company's internal strategy	Value	Score	Weighted value
Mine	0.5	5	2.5
Plant	0.35	5	1.75
Organizational culture of the company	0.15	4	0.6
Total Values	1		4.85

The following table elaborated with the trend lines is developed, adding to this the influence of internal qualitative data already evaluated. Generating new monthly forecasts (Fig. 3).

Budgets evolution with external data						
DEC	JAN	FEB	MAR	APR	MAY	JUN
$ 2,814,809	$ 2,483,598	$ 2,563,742	$ 2,641,431	$ 2,716,687	$ 2,789,533	$ 2,859,991
$ 2,814,809	$ 3,287,803	$ 2,693,610	$ 2,806,834	$ 2,919,245	$ 3,030,848	$ 3,141,645
$ 2,814,809	$ 3,287,803	$ 3,204,371	$ 2,842,716	$ 2,977,317	$ 3,112,243	$ 3,247,494
$ 2,814,809	$ 3,287,803	$ 3,204,371	$ 3,162,061	$ 2,949,770	$ 3,098,215	$ 3,247,731
$ 2,814,809	$ 3,287,803	$ 3,204,371	$ 3,162,061	$ 4,101,455	$ 3,236,866	$ 3,421,281
$ 2,814,809	$ 3,287,803	$ 3,204,371	$ 3,162,061	$ 4,101,455	$ 3,982,613	$ 3,448,203

Fig. 3. Forecasts with trend lines influenced by qualitative technique by points.

We proceed to develop the graphs and compare the variation to measure the results and reduce the uncertainty handled by the company in addition to the Forecast methodology influenced by qualitative data (Table 2 and Figs. 4 and 5).

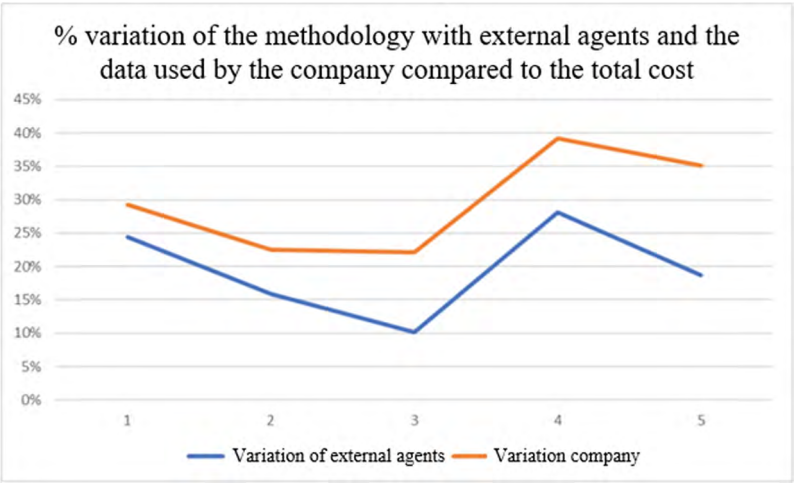


Fig. 4. % Variation in forecast uncertainties for total budget.

Table 2. Uncertainties in the general budget projected by the company

Month	Total cost	Variation of external agents	Variation company
Jan-16	$3,287,803	24%	29%
Feb-16	$3,204,371	16%	22%
Mar-16	$3,162,061	10%	22%
Apr-16	$4,101,455	28%	39%
May-16	$3,982,613	19%	35%



Fig. 5. Ratio of the price of gold to the estimates executed by the company

After comparing the variations, we can affirm that the behavior of the price of gold has a direct correlation with the application of the budget.

5 Conclusions

The use of qualitative by points to evaluate the effect of external agents on the Forecast of the price of gold generated an uncertainty in an Interval of 7%–13% with the real price in a monthly horizon. When the influence of external agents was evaluated by qualitative points, the uncertainty of the Forecasts prepared by the company was reduced by up to 50% with respect to those managed by the company in relation to the actual cost executed. The forecasts were handled in a range of 10%–28% compared to the real ones. The uncertainty handled in the mine area with respect to budgets is in a range of 35% maximum and 20% minimum. Being the months after March an uncertainty close to 20%. Uncertainty managed in the process plant budgets was reduced in some cases up to more than 50% with respect to the one managed by the company. The uncertainty of the qualitative methodology by points in the process plant area generates an uncertainty interval of 0%–18%.

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Creative Packaging Design for Products

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Abstract. The packaging is part of the final product and its ergonomic design becomes a purchase motivator. They fulfill different functions, such as: protector, conservator and provides logistical security of the product, among others. The use of technological tools as a transforming element in digitization, printing and prototyping accelerates the process and significant savings are achieved in the use of materials. In the prototyping stage, it is designed according to the product and different methodologies are used, such as participatory design and design thinking, before its construction. The objective of this research is to present the experience of higher education students in the design of prototypes using disruptive tools focused on the construction of packaging. 18 graphic design students participated, who managed to generate 3 prototypes, which were tested by direct observation in the Gesell chamber with 5 children with disabilities, 8 early childhood teachers and 8 parents separated into groups due to similarity. Digital modeling and the use of ecological substrates (earth pact) with their own colors and diverse textures, friendly to the environment, generated an appeal to the end user prior to production. The use of lasers in the die cutting process creates an attractive color effect (dark beige) by burning the paper. In the future, the aim is to work with other substrates (papers and cardboard) that allow measuring durability and malleability (if it can be easily bent without being damaged).

Keywords: Ergonomic design · Prototyping · User experience design · Design thinking

1 Introduction

Protecting and preserving the product are functions of a packaging. According to several authors, the main function of a packaging is to be a motivator for the purchase [1], it must also keep the brand image active in the mind of the consumer. The designs of the wrappers on the products must tell the experience that the consumer will have with the packaged product, using colors according to the emotional sensation [2]. Graphic details are important elements in packaging [3], for this reason, its conceptualization must be worked with great care to obtain the expected results.

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 907–911, 2022.
https://doi.org/10.1007/978-3-030-85540-6_115

The use of the design thinking methodology in the classroom allows to achieve results in the short term and with very favorable results [4]. Through teamwork, students integrate research and gamification, motivating its use and achieving results above expectations [5]. Getting students out of their comfort zone and awakening their creativity to achieve goals allows them to achieve innovative results, as part of the experience that can be obtained with this methodology [6].

When deciding to buy a product, concern for the environment is related to the packaging and, secondly, that it does not generate a health hazard, they are two main reasons for its consumption, especially if it is food [7].

This article has a bibliographic analysis regarding the use of packaging, user experience design, design thinking, augmented reality and the different methods that will be used for the development of the educational product. The second section presents the methods used to develop the proposal. The third section presents the generated model with which the investigation will be carried out. In the fourth section, the proposed model will be compared with those existing in the market, exposing the advantages and deficiencies of the same at the time of achieving a result. Finally, conclusions and future works related to the subject of user experience design and its relationship with editorial design with AR and user experience design are presented.

2 Methods and Materials

2.1 Design Thinking

This research is based on the methodology developed by Tim Brown, called Design Thinking, developed at Stanford University in California (USA) from the 70s [8], as a tool that allowed evaluating software and that due to its adaptability has allowed its application and use in any activity that seeks to solve problems, including education, which is the space in which the prototypes have been designed made by graphic design students.

It is developed in 5 phases: Empathize, define, devise, prototype and test [9], as presented in Fig. 1. Empathizing allows us to understand the user archetype to which the packaging production will focus. Define allows you to organize all the information collected for use, analysis and synthesis. Idear leads to the generation of solutions in a conceptual way. Prototyping sends ideas into practice. And testing leads us to confirm if what is generated is what is expected or if some arrangement, change, modification should be made.

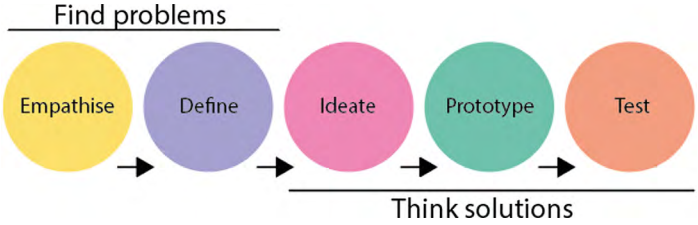


Fig. 1. Scheme of the Design Thinking Methodology prepared by the authors

2.2 Participatory Design

It is a methodology born in Scandinavia with the name of Cooperative Design and that changed its name to Participatory Design when entering the North American community, in which the division between managers and workers was very large and it was seen that that name was the most ideal for its development and application. With this methodology it is possible to integrate knowledge of different social actors, in this way the knowledge of contextual needs is integrated, which favors the construction of responses adapted to a specific reality [10].

3 Proposed Model

For the development of this research, we worked with 18 graphic design students, who worked in workshops with the Design Thinking methodology. In the first stage, the students carried out a historical bibliographic survey of types of board games, visited the main stores in the city where this type of products are marketed, and searched online for existing options in the national and regional market. With this, the empathizing phase was covered. In the definition phase, the creators of the board game presented the dynamics of the game, its conceptualization, elements and materials and it was possible to observe the need for a personalized packaging for the board, cards, cards and other elements. In the next phase, the students proceeded to work in three teams on building prototypes for the board game packaging. After its development, the Gesell room was used in which it was tested with 5 children with disabilities, 8 basic education teachers and 8 parents, separated into groups by similarity. At this stage, the students received information on their prototypes, where details were found that needed to be reviewed and modified. A new meeting of the working groups was generated, but on this occasion the results obtained in the testing were shared and it was agreed to generate a single final proposal that contains all the modifications requested by the users. We proceeded to work on the final design of the box die and its interior parts (Fig. 2), on the graphic design of the cover (Fig. 3) and emphasis was placed on complying with the suggestions received in the previous stages, related to shape, illustrations, fonts, use of color, texture and use of materials. The construction of the final design was carried out in recycled cardboard, which has international environmental certifications and for the die-cutting of the box, a correctly calibrated cnc laser cutting machine was worked, which allowed to obtain an exact and clean cut, which generated an effect special color on the edges due to the use of laser.

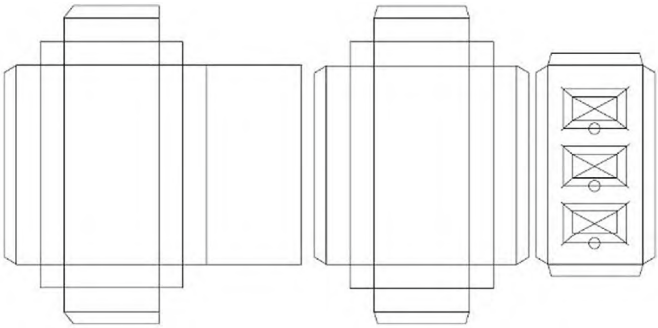


Fig. 2. Final approved structure of the die that corresponds to the interior spacers of the box made in the project design process.



Fig. 3. Design and final structure of the exterior design of the developed board game box

4 Conclusions

The development of this research allowed graphic design students to obtain an experiential academic experience in the development of a package for a real client. The proper use of the methodology by the teacher allowed the group of students to demonstrate their leadership to work as a team with successful results. The motivation achieved, the technological resources available to the university, the participants and the subject allowed to develop an experience with favorable results.

The previous bibliographic research carried out by the students allowed them to develop their imagination, taste and attractiveness for good design, which was reflected in the products presented.

Finally, in the future it is planned to develop new studies focused on the use of different types and weights of cardboard, as well as the use of laser cutting and laser engraving.

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Playful Environment as an Aid to the Treatment of ADHD in Times of Pandemic

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Abstract. Although children suffering from attention deficit hyperactivity disorder tend to be nervous, not concentrated in specific jobs, anxiety that is transmitted to all those who are confined to the family, reviewed studies evidence that there are a large number of families that are affected by post-traumatic stress that obviously affects the whole home, the proposal is to create a playful environment capable of presenting scenarios that allow children to discharge their energy and focus on the educational environment, health and family well-being. The environment aims to be a counseling system that allows to identify the mood of the infant and proceeds through an intelligent system to deliver specific tasks aimed at improving the quality of life and reducing the level of anxiety, as well as helping concentration through the intervention of the family as a group or support group, we will focus on children from 4 to 6 years where children already enter virtual classes in most cases.

Keywords: COVID-19 pandemic · ADHD · Therapeutic tools · Learning · Inclusion · Education

1 Introduction

On March 11, the World Health Organization- WHO defines as a COVID-19 pandemic [1, 2]; date that proceeds worldwide closure of borders, isolation of the nucleus of society [3, 4]; the family, complicating to develop our responsibilities, forcing us to carry out almost all activities through technology [5, 6], such as: telemedicine, teleworking, distance education, tele therapy among others [7, 8]; this confinement of about two months had an overall socio-economic impact [9, 10]; changed the home; increasing stress, anxiety, increasing the vulnerable population [11, 12]; especially people with functional diversity [13, 14], this section will talk about those who suffer from attention deficit disorder, impulsivity and hyperactivity - ADHD [15, 16], the same people who, during confinement, exacerbated their deficiency, did not receive an inclusive education, in some cases their therapies are paralyzed since not everyone has access to a computer and the internet [17, 18]; adding to their symptoms stress, depression, insomnia, hypervigilance, self-harm, domestic violence, etc. [19, 20]; but as the days went by they got

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 912–921, 2022.
https://doi.org/10.1007/978-3-030-85540-6_116

used to a new schedule [21–23], to a new routine where some receive classes through the media and the internet, do not have the pressure of orders from people outside their family environment [24, 25], parents become aware of the cognitive situation of their children, they strive to continue with teletherapies [26, 27], children do not want to return to schools, they prefer to learn and continue their therapies with their parents [28, 29]. Both the Ministry of Public Health and the Ministry of Education improve their platforms [30–32], they know the missing, that the rights of health, education, social welfare in general are being violated, [33–36] observing the need to evolve digitally [37, 38], develop media, toys, therapeutic robots, virtual tools and/or accessible intelligent systems [39–41]; to reduce the existing gap in inclusive education, health and good living [42, 43]. These intelligent systems will encompass playful learning [44, 45] which is based on therapeutic games, which are the foundation of cognitive behavioral therapy, which is used as a treatment for attention deficit, impulsivity and hyperactivity disorder that will create a playful environment during the pandemic and coexistence with COVID-19 [46, 47].

1.1 Attention Deficit, Impulsivity, and Hyperactivity Disorder

Attention deficit, impulsivity and hyperactivity disorder – ADHD is a debate, a dyssynchronous of the neuronal and with the physical causing defects in its executive functions [2, 5], this disorder can be both in 76% genetic parents who suffer the same anomaly and 50% of parents or relatives who suffer from another functional diversity and for external or environmental causes [4, 6, 7], for example: environmental pollution, consumption of toxic substances during pregnancy, precarious situation at birth, malnutrition of the mother or during her childhood, consumption of dyes during pregnancy, contact with lead, strokes or brain trauma, among others; causing symptoms that hinder their adaptation at home, school and in society [3, 8, 11]; therefore their lifestyle is precarious, the child is excluded [10, 13]; consequently his family is withdrawn, not participating in the community [12, 14]. In addition, this disorder can develop at any age and is difficult to detect [15, 16], especially in the infant's early years because its symptoms are similar to the behavior of its age; which complicates their treatment and unconsciously by their caregivers, these symptoms are increased by thinking that it is due to lack of discipline [19, 25]. There is a wide range of symptoms that allow you to be classified into four types of ADHD [26, 27]: the first is in afferent, disorderly, short memory, boredom, distracted, clueless, indifferent; second: hyperactivity and impulsivity, excessive restlessness, scandalous, troublemaker; third: mixed ADHD, aggressive, impetuous, abrupt, sudden change of behavior, conflictive mental health and fourth: ADHD with coexistence with other disorders such as ASD, Down Syndrome, Learning Disabilities, schizophrenia, etc., the latter type of ADHD is more vulnerable, has a weak immune system, adheres to any disorder, disease or anomaly [29, 35]. People with ADHD according to their medical history receive treatments with drugs and/or therapies that cover the cognitive, behavioral, educational, family, and social deciphering and creating skills to continuously adapt to their environment [32, 34, 36].

1.2 Pandemic

The coronavirus is a set of viruses similar to those of the Middle East respiratory syndrome -MERS, severe acute respiratory syndrome SARS, HIV, multisystem inflammatory syndrome-MIS that attack and weaken the immune system causing the disease called COVID-19 [1, 2, 5], which may be silent, without symptoms; in others it is presented as a stationary cold [4, 6, 8], and in other cases accelerates the reproduction of defective cells decreasing the body's defenses causing chronic diseases to which that person is more prone or a multiorgan failure to death [7, 9, 10], that is, COVID-19 infects a weak immune system and enters the body through the mucous membranes [11, 12, 14]; so they decree as prevention measures the isolation, use of masks, avoid bringing the hands to the face, ant fluid suits, cleaning and disinfection of all element and surface [15–18], they also discover that salivary particles from a silent carrier remain in the air for several hours indicating that the distance of two meters is not enough; that the temperature intake does not cover asymptomatic infected [3, 19, 25]; which makes it difficult to reduce cases of contagion and ask that they leave only if strictly necessary in compliance with all biosecurity measures [26, 28]. However, the number of deaths from COVID-19 is rising globally, on March 11, 2020, the World Health Organization declares the disease of COVID-19 as a pandemic, border closure and family isolation [27, 29]. A year has passed and to date it is known that the symptoms are similar to a cold, a seasonal flu, intestinal infection, migraine, breathing difficulties, muscle discomfort, pneumonia [30, 32], aggravates the symptoms of any disease suffered such as diabetes, pulmonary, cardiac, pressure, leukemia, partial thrombosis or even multiorgan failure due to the addition of platelets in blood vessels at risk of death [31, 33, 35]. Confinement increased stress, insecurity at the first symptom such as headache or sneezing went to hospitals, health centers or any health facility causing instability, sources of infection [34, 36, 38]; to avoid crowding in these; improved their platforms [42, 43], telemedicine, teletherapies, itinerant clinics, however it was not enough, anxiety, stress dominated the population [44, 46], then, they pointed out how to differentiate the symptoms of COVID-19 from a cold, a flu or intestinal infection (See Table 1), thus decreasing the anguish of feeling infected by the coronavirus [45, 47].

Table 1. Differences in symptoms between cold, flu, infection, and COVID-19

Symptoms	COVID-19	Cold	Influenza	Infection
Fever	Upper temperature	Temperature 0°	Temperature 38°	Flashing temperature 38°
That	Dry cough without sputum	Moderate and phlegm	Non-productive: dry cough	
Weariness	Middle	Lightweight	Lightweight	

(*continued*)

Table 1. (*continued*)

Symptoms	COVID-19	Cold	Influenza	Infection
Muscle aches and pains	General pain at once, especially in the back until you cannot breathe	Mild and gradual pain of the extremities	Arms, legs and back, pain of blow	Gradual pain of Extremities
Diarrhea	Upset stomach			Upset stomach
Nausea	gradual	Nauseas by medication instantly		All at once until everything is ejected
Time	Increases symptoms	With or without medicine decreases symptoms in a week		

1.3 Treatment

A medical treatment is a set of methods to relieve or decrease the symptoms of a disease [3–6], in the case of ADHD, the genetic causes are first investigated [7, 8], socio-environmental factors and medical history with the help of qualitative information scales, quantitative computer tests, continuous execution tests and care variables, medical examinations [9, 10], then they are analyzed, they are collected to a clinical picture [11, 12], it continues with a multidisciplinary diagnosis combining minimal specialties such as psychiatry, psychology, neurology, general medicine because this disorder affects all fields, it continues with a multidisciplinary diagnosis combining minimal specialties such as psychiatry, psychology, neurology, general medicine because this disorder affects all fields [13]; it is important to treat each and every one of the symptoms that the infant has [14, 15]. This treatment involves continuous diagnosis because it covers cognitive, behavioral, educational, emotional, social and medical elements allowing to improve their skills, increase their creativity, decrease their defects and create positive skills for a good quality of life through therapies and/or drugs [16–18]. One of the therapies used to treat ADHD is cognitive behavioral therapy-CBT that starts from the theory of learning based on critical observation, modification, experiment, decreases the empirical, inventions, adoption, evaluation and creation [20, 21], that is, it learns to know, to be, to live together and act, as this proverb quotes "when I hear forgetfulness, when I see memory, when I do I understand" [22, 23]. This therapy defines "what you think can determine what you feel" [24, 25], it is a therapy of the moment "here and now" [26, 27], it is a set of heterogeneous psychological processes that involve a wide variety of functional diversities through the analysis of body expression, facial, intonation and response to external stimulation; its goal is to identify cognitive disturbances, stop, minimize them, change negative behaviors and thoughts to positive ones [28, 29] establishes a cognitive restructuring behaviorally where the infant is a defender, lawyer and judge, understands his self, recognizes that as he believes he feels and acts generates his behavior and feelings; it breaks the maleducative cognitive scheme by helping it resolve its conflicts with other reasoning and motivates adaptive behavior allowing its inclusion and social experience

[35, 36]. In addition this therapy continuously demonstrates or rules out hypotheses due to its covariation of symptoms and its improvement [37, 39]; reason why this therapy is applied individually and in groups [41, 42] through simple, therapeutic games and playful activities [43, 52], facilitating its implementation to toys, robots, therapeutic tools, intelligent systems or instruments of information and communication technologies-ICT [44, 45] that during the pandemic they will help to continue with these therapies by creating a playful environment in their home-office-therapy [46, 47].

1.4 Playful Environment

A playful environment is understood as a harmonious environment where the child relates to his or her habitat through play [8–11], same that is the initiative, imagination, decision-making, the physical - mental - verbal combination, the expression, meaning, meaning and interpretation of the world [12–14] that surrounds him by consciously and unconsciously obtaining knowledge, promoting his arts [15–17, 39, 41], motivating them to investigate, to discover, to create, to increase their wisdom, their social, cognitive, sensory, psychomotor skills; to be empathetic, to enhance all their senses especially smell, touch; improve their language management, expand body expression, solidarity, to understand what an inclusive education is [18, 19]; non-discrimination, non-stigmatization, value, respect [20–22], that we all learn and teach no matter the age [23, 24], stimulates concentration, mint agility, favoring adaptive physiological responses, innovating and learning from reactions [25, 32, 33] for your well-being and that of your whole family by decreasing stress, anxiety, distress, insecurity, symptoms of TDHA [38], and that were exacerbated by confinement due to the pandemic and injecting optimism into the community causing a positive impact on the health of the community [46, 47].

2 Proposal

The COVID-19 pandemic changed our routines, changed schedules, changed the methodology of doing our activities [1–4], most of these are done through technology such as telemedicine, teleworking, distance education, tele therapy [5–8]; but not everyone has access to these and those who could does not guarantee the good use and quality of these [9, 10]; so we developed ways or methods to impart measures or advice to create a playful environment as a treatment for children with or without TDHA that are based on cognitive behavioral therapy - CBT transforming their behavior, thought, feeling, interpretation of the situation maladaptive to a behavior, thought, feeling and optimistic situation [11–13]. At the beginning of the pandemic, children with ADHD suffered instability due to the change of their daily schedule from school to home, to therapy and return home, aggravated their symptoms in infants with:

- ADHD with attention deficit: isolation, decreased their social skills developed so far in schools, acquired phobias to go out, people different from their family, Vivian in their world, indifferent to what was happening around them [14, 16].

- ADHD with impulsivity and hyperactivity: increase their aggressiveness, self-harm, attacks on siblings and parents, stress, domestic violence, anxiety, depression, anger, claustrophobia, did not have enough space, aggravating situation in large families that are confined in apartments or houses without a patio [15, 19].
- Mixed ADHD: suffering, restlessness, impulsivity, aggression from one moment to another, hypervigilance, insomnia, panic, your mental health in danger [17, 18].
- ADHD with coexistence of other disorders: increased abnormalities, adding nervousness, stress, depression, disorientation, worry; some stopped studying, did not continue their therapies; others tried, but both teachers and parents were complicated to reach the infant either by not using digital tools correctly, platforms stopped working, computers that are not advanced enough to support telemedicine or tele therapy [14, 16, 20].

After the quarantine they allowed to leave the houses with all the biosecurity measures but after confinement, in the new normal [21, 22]; children do not want to go out for fear of getting sick, they do not want to attend schools or therapies, they depend on mom or dad or both causing family neuroticism, I added other disorders such as sleep, eating, personality, phobias [23–25]; the parents said that in most cases of TDHA the behavioral symptoms they felt when returning from school decreased, and that they prefer to avoid trips to attend school and therapies, that they do not stress about not arriving on time, that they became accustomed to distance education to listen to it or see it through the media, computer, cell phone and/or telephone; that with teleworking, distance education and tele therapy they have more time with their children, become aware and learned to know their children and their limitations [26, 27].Therefore, most families continued with cognitive behavioral therapy and others began to adopt it during the pandemic, as mentioned above is based on therapeutic games being the best way to learn with their children [28]. This treatment of ADHD with cognitive behavioral therapy that is individual and group is implemented by algorithms to intelligent systems that quantitatively evaluate the progress of therapy strengthening its capabilities, decreasing its shortcomings, developed socio-affective relationships; through observation (cameras) and by pressing the keyboard (sensors), whose impact on teaching, learning and cognitive development forming a playful environment, a virtual learning environment (AVA) [29, 30]; which includes daily iterations of teacher and/or therapist-parents-infants-ICT (information and communication technologies), parents with therapeutic guidance: converse and explain to children in a simple way the situation of COVID 19 weekly without transmitting denials or stress, and for them to accept biosecurity measures they must stimulate the child with some techniques of cognitive behavioral therapy- CBT [32, 34] for example in critical cases of ADHD with coexistence with other disorders such as ASD and social phobia we can use the technique of exposure, upward arrow, modeling [36, 37] and self-instructional training: watching a superhero or monster movie according to the taste of the infants, simulating a drawn, virtual or theatrical scene where the superhero fights the COVID-19 monster or creating comics where children are superheroes who need to wear the ant fluid suit and masks so that they do not discover their powers, that frequent hand washing increased their strength while singing a spell; that during the journey from their home to anywhere they should avoid taking their hands to their faces because it diminishes their powers, that cleaning and disinfecting every

surface creates a transparent, invisible shield that protects you two meters away from the tiny minstrels that are part of the great COVID-19 monster [35, 38, 39]; however, it is necessary to dissipate that energy, that hyperactivity involucels in the daily and group activities like cooking, singing, dancing, painting, drawing, writing, reading, investigating, inventing, cutting, experimenting or creating comics, stories, cleaning, fixing, sewing or decorating the whole house or objects, board games (domino, chess) that forge their psychomotor skills, creativity, capture concepts of mathematics [42, 43]; for example if they join two equal triangular figures and their sides have the same size they form a square or two equal triangles with two equal sides form a rhombus; they can also perform teams and compete in plays, musical band or discover places, games with challenges, pantomimic, jump, walk around the room or rhythmic exercises breathing slowly, meditate, pet their pets or plant/caress plants, practice yoga [31, 33, 41]; if you have a yard ride on bicycles, play with the ball, symbolic games such as family, little things, construction, school, your mom or dad's work, etc. who instill and increase their resilience, empathy, leadership, positive emotions, overcome their fears, face and resolve conflicts, negotiate, self-control, respect, interact with others, become more supportive and share time with their grandparents and/or siblings [44, 45], all this allows a cognitive restructuring both for the infants and the whole family, increasing the confidence of each one, not feeling alone, the siblings take care of each other while their parents are in the telework [46, 47] (See Fig. 1).

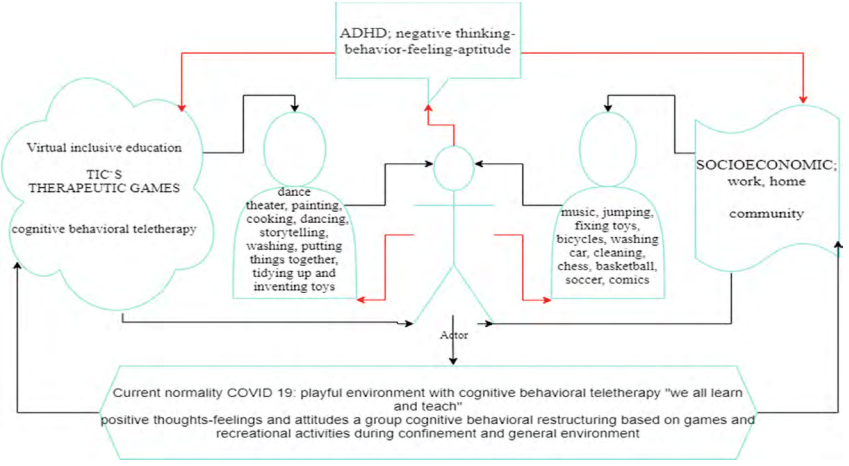


Fig. 1. Proposal of play environment as an aid to the treatment of children with ADHD.

Consequently, the proposal of the recreational environment as an aid to the treatment of infants with ADHD during the pandemic and the new normal: living with COVID-19, must comply with an inclusive education, we all learn, implementing techniques of cognitive behavioral therapy that is based on play or playful learning, interrelationship of child-family-teacher/therapist-ICT in a virtual learning environment (AVA) projected to a peaceful environment of the home performing together the daily activities where the treatment of ADHD is implicit, pedagogical methodologies and therapeutic games

that minimize the symptoms, innovate reactions to adaptive or positive aptitudes, no stress, no depression, non-domestic violence, solidarity, resilience, physical and mental strengthening, meaning a better lifestyle and social well-being.

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Electricity Consumption Forecasting in Iraq with Artificial Neural Network

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Abstract. The goal of this paper is to predict electrical energy consumption using nonlinear autoregressive (NAR) models. The practical section contains historical data on Iraq's annual electricity consumption rate from 1980 to 2013. The most significant findings are that neural networks perform better at predictive analytics due to the hidden layers. To make predictions, linear regression models only use input and output nodes. The hidden layer is also used by the neural network to improve prediction accuracy. This is because it 'learns' in the same way that humans do. It is recommended that further research be undertaken in the following areas Intelligent forecasting methods are being used as an alternative to traditional forecasting methods.

Keywords: Artificial intelligence · Neural networks · Nonlinear autoregressive · Intelligent prediction

1 Introduction

Many tasks involving intelligence or pattern recognition are extremely difficult to automate, but humans appear to handle them with ease. Humans, for example, appear to recognize a variety of objects and make sense of a large amount of visual information in their surroundings with seemingly little effort. Understanding how humans perform similar tasks and simulating these processes to the extent allowed by physical limitations will undoubtedly benefit computing systems attempting similar tasks. Neural Networks must be studied and simulated to achieve this. A human's neural network is a part of his or her nervous system, and it consists of many interconnected neurons (neural networks). Predicting methods based on simple mathematical models of the brain are known as artificial neural networks. They permit complex nonlinear relationships to exist between the response variable and its predictors. A neural network can be thought of as a network of interconnected "neurons" organized in layers. The bottom layer is made up of predictors (or inputs), and the top layer is made up of forecasts (or outputs). There could also be intermediate layers with "hidden neurons." The new and promising method of

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 922–927, 2022.
https://doi.org/10.1007/978-3-030-85540-6_117

prediction for time series is artificial neural networks (ANNs). As a result, forecasting has received a great deal of attention in the previous. Nonetheless, Today and in the future it is an important and active field of human activity. Many studies have found that artificial neural networks are better than traditional models for prediction methods [1–7]. The paper is organized into three major sections: introduction, methodology, theoretical aspect, practical aspect, results, and conclusions.

2 Method

2.1 Time Series

A time series consists of a collection from observations of a quantified quantity ordered by their in-dices.

An analysis in time series allows you to over time analyze, describe and explain a phenomenon while making a choice. Prediction is single of the prime objectives of time series analysis, This means that future series values based on current values are predicted [1, 2, 8, 9].

2.2 Neural Network

Artificial intelligence constitutes Neural Networks. Network learning is done through a weight and layer adjustment to the connection between inputs and desired outputs. The multifaceted perceptron network (MLP) is one of the most basic models in many applications. It describes complex connections of independently and dependent variables in conjunction with nonlinear functions. The MLP was first used to solve complex problem classification. These models are excessive, and many local minima are necessary to minimize error functions, and implementation is often difficult. Figure 1 shows how to prepare a NRT to foresee a time series based on its predecessor values (y_{t-1}, y_{t-2},..).

A network of neural systems for the projection of time series, a Non-linear Nonlinear Autoregressive Model which can be automatically written in this format [1, 2, 4–7]:

$$y_t = h\left(y_{t-1}, y_{t-2,} \ldots\ldots, y_{t-d}\right) \tag{1}$$

The function h(.) It is unknown before long and the formation of the neural network aims to approximate it by optimizing network weight and optimizing neurons [1, 2, 10].

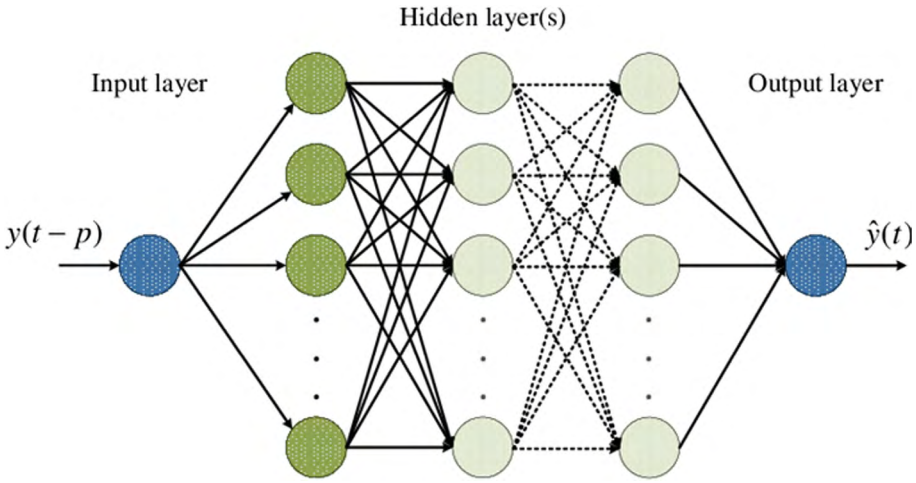


Fig. 1. A nonlinear autoregressive neural network's structure.

2.3 Evaluative Criteria

Various performance indices can be used to assess the perforation of the model. Performance indicators such as root mean square error (RMSE) and coefficient of determination R^2 were used to evaluate model results [3, 6, 8, 9, 11, 12].

$$\mathrm{RMSE} = \left(\sum e_t/n\right)^{1/2} \tag{2}$$

$$R^2 = \left(\sum y_t - \overline{y}\right)/\left(\sum \hat{y}_t - \overline{y}\right) \tag{3}$$

Where:

$$e_t = y_t - \hat{y}_t$$

3 Result and Decision

The NAR method is demonstrated in this study using the well-known data sets of Iraq's annual electricity consumption rate data. These time series come from a variety of places and have a variety of statistical properties. The data we are looking at includes Iraq's annual electricity consumption rate from 1980 to 2013. Figure 2 shows the electricity consumption rate.

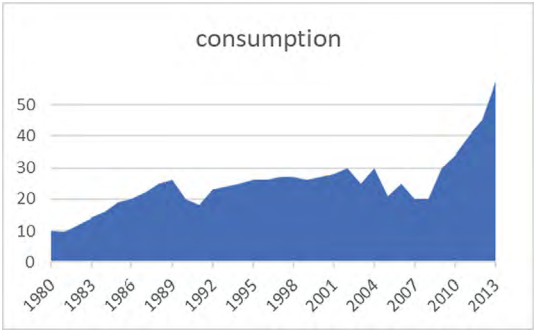


Fig. 2. Iraq's annual electricity consumption rate from 1980 to 2013

Model forecasting results were calculated. The MATLAB high-level programming language is used to estimate neural network forecasting results to generate results. After several experiments, the best number of nodes in the hidden layer is 15 nodes, with one layer. The input nodes of this time series are the observations at delay 1, the previous (lag) observations are at t−1, that is, Xt−1, and the output is Xt. Figure 3, 4 and Table 1 shows the network performance results.

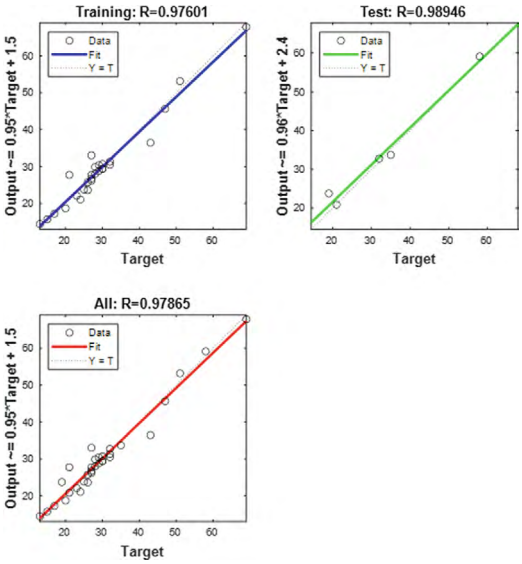


Fig. 3. Network evaluation in training and testing

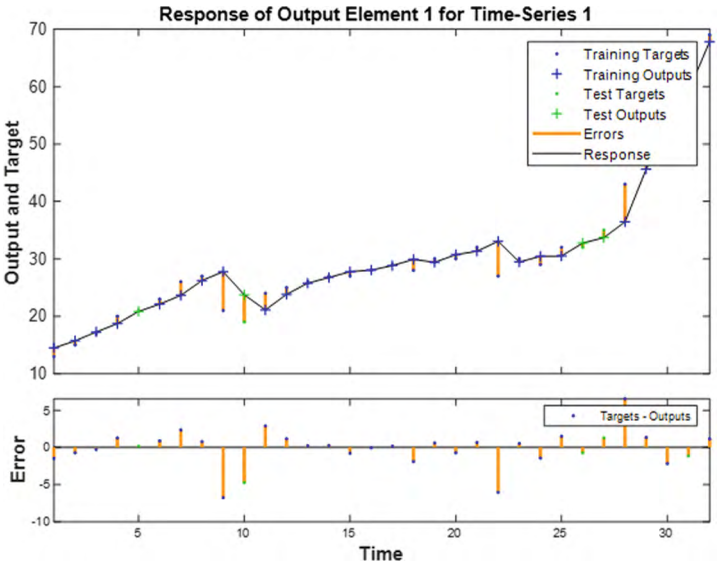


Fig. 4. Output response

Table 1. Evaluation criteria

RMSE	2.4
R^2	0.975

Figures 3 and 4 show that the values of R and response of output element for both the training and validation data sets are nearly identical to those for the test set for all developed neural network models. As Table 1 shows, there is a significant result of the error accuracy evaluation criteria.

4 Conclusion

Over the last few decades, there has been a lot of interest in time series analysis and forecasting. Because the accuracy of time series forecasting is critical to many decision processes, research to improve the efficacy of forecasting models has never stopped. In general, ANNs thrive in data-rich environments, which encompass a wide range of scenarios. At the very least, ANNs can be used to detect nonlinearities in data that traditional forecasting methods miss. This finding suggests that NAR can be used to generate more accurate forecasts. The relevance of NAR to predict time series, whether they are linear or non-linear is supported by the current findings.

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Wearable Technologies and Affective Computing



Effective Selection Method of Microphones for Conversation Assistance in Noisy Environment

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Abstract. When hearing aids are used in a noisy environment, it is susceptible to noise because built-in microphones alone are used to capture voice. The ultimate goal is to develop a system that efficiently suppresses noise entering a hearing aid by combining multiple microphones located at different positions from the hearing aid. As a preliminary step in building this system, in addition to hearing aid built-in microphones, we placed several microphones between the subject and the conversation partner, recorded under various conditions. And, main microphones and external microphones were evaluated for noise impact and speech intelligibility on a five-point scale. As a result, the evaluation items were scored approximately up to two levels higher, and the external microphone reduced the effect of noise and improved listening comprehension. Therefore, the use of external microphones may solve the problem of hearing aids that have challenges in using them in noisy environments.

Keywords: Hearing aid · Multi microphone · Conversation assistance

1 Introduction

Currently, there are about 343,000 people with hearing disabilities in Japan [1]. However, this is the number of people with hearing impairment recognized by the government, and there are probably many more people with potential hearing loss. In addition, "JapanTrak" surveyed randomly selected people based on age, gender, etc. to determine the percentage of people with hearing loss and hearing aid ownership. The results showed that 13.5% of the hearing-impaired population owned hearing aids [2]. This result shows that the hearing aid penetration rate in Japan is very low, as it is 30–50% in Western countries [3]. One of the reasons for not using hearing aids and users' dissatisfaction is the problem of using hearing aids in noisy environments [2, 4]. When using a hearing aid in a noisy environment, it is susceptible to noise because only the built-in microphone of the hearing aid is used to capture sound. Currently, hearing aid manufacturers are selling wireless microphones specifically designed for hearing aids to help people hear in noisy environments. In this system, the hearing aid acts as a receiver and the wireless microphone acts as a transmitter. The conversation partner inputs voice into the wireless

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 931–937, 2022.
https://doi.org/10.1007/978-3-030-85540-6_118

microphone, and the hearing aid wearer hears its voice directly in the appropriate setting [5, 6]. In this study, we propose a noise suppression system that combines such an external device with a hearing aid. As a preliminary step in building this system, in addition to the hearing aid's built-in microphone, we placed several microphones between the subject and the person with whom he was speaking, recorded under various conditions, and evaluated the differences.

1.1 Proposed Method

The system we are proposing uses a hearing aid built-in microphone and an external microphone located at a distance from the hearing aid wearer. Even in the same environment, the characteristics of the audio that can be captured may differ depending on the positioning and type of microphone. Therefore, we wondered if it would be possible to improve the performance of hearing aids by using two types of audio data with different feature values due to differences in recording locations. The proposed method is shown in Fig. 1 as a block diagram. Input is from "M1" and "M2" microphones, "P" is gain, and output is "D" speaker. Assuming that M1 is the built-in microphone of the hearing aid and M2 is the external microphone, they are located far apart. The target signal, "signal(t)," and the noise signal, "noise(t)," are input at M1 and M2 in the same noise environment. However, because these are microphones with different positioning, each signal is input with different characteristics. The signal-to-noise ratio of each input signal is compared, and we set the signal with the lowest signal-to-noise ratio as "nx(t)," and the noise signal "$\hat{n}$(t)" is estimated by the discriminator. Next, the signal with high signal-to-noise ratio "sx(t)" and the estimated noise signal "$\hat{n}$(t)" are used to perform noise processing using the spectral subtraction method (SS method) [7]. In this way, it may be possible to perform more accurate noise processing by efficiently adding processing according to the characteristics of the audio captured by each microphone. Therefore, in this study, we actually recorded with each microphone in a noisy environment, simulating the situation when a hearing aid is used, in order to evaluate what kind of difference there is in the audio that can be captured depending on the position and type of microphone in various environments.

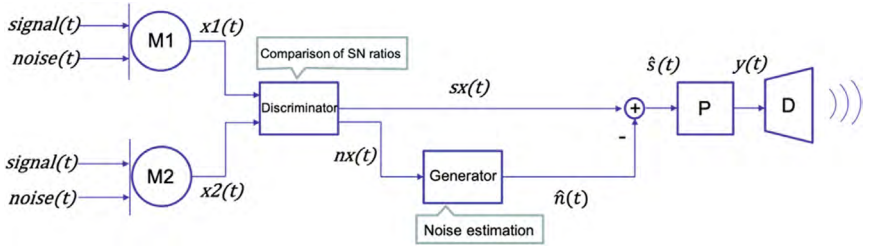


Fig. 1. Block diagram of the proposed system

2 Evaluation Data Conditions

In order to evaluate what kind of difference there is in the audio collection data depending on the position of the microphone, we recorded audio for evaluation, assuming a face-to-face conversation.

2.1 Recording Apparatus

The microphones used in this recording are listed in Table 1. In this experiment, the microphone in the subject's ear is the "main microphone," and the microphone placed between the subject and the conversation partner is the "external microphone". For the main microphone, an earphone-type microphone was also used to compare the level of the hearing aid's built-in microphone's ability to record audio. For the external microphones, unidirectional microphone and an omni-directional microphone were used in order to compare the changes in the recorded audio due to the difference in directivity. As for the microphone built into the smartphone, it is one of the most familiar microphones, and we used it to verify whether it could be substituted as a wireless microphone.

Table 1. Microphones used for recording

	Microphone type	Manufacturer	Model number
Main Mic. 1 (M1)	Hearing aid built-in Mic	Panasonic	WH-15C
Main Mic. 2 (M2)	Earphone-type Mic	Roland	CS-10EM
External Mic. 1 (E1)	Unidirectional condenser Mic	SONY	ECM-530
External Mic. 2 (E2)	Omni-directional condenser Mic	JTS	CX-500
External Mic. 3 (E3)	Smartphone built-in Mic	Apple	iPhone7

2.2 Audio Source Data

We describe the audio source data used in the recording. In this study, two types of noise data and one type of speech data for conversation were used. We used the sound of train running and the buzzing sound in a cafe as noise [8, 9]. In this study, both audio data were set to ± 10 dB based on 70 dB, and a total of six types of noise were used. We used one type of balanced audio data as the conversational speech [10]. The conversational speech level was set at 75 dB, a value slightly higher than the noise standard of 70 dB.

2.3 Recording Method

The location of each of the microphones used is shown in Fig. 2. The distance between the subject and the conversation partner was set at 2 m, based on the social distance, which is a measure of the prevention of the spread of covid-19 infection [11]. The position of the external microphone was varied in three patterns: 0.5 m, 1.0 m, and 1.5 m from the subject. The audio for noise was output to the four corners of the room using S2–S5 in Fig. 2. The conversational speech was output from S1, the speaker for the conversation partner, to the subject. Simultaneous recordings were made with five microphones using free software called "audacity" at a sampling frequency of 48 kHz and a quantization bit rate of 32 bits under multiple noise conditions in a soundproof room with a dark noise level of 20.9 dB [12].

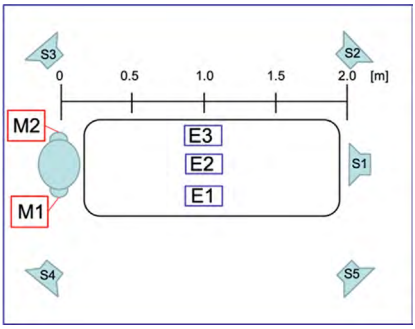


Fig. 2. Layout of the equipment used in the recording

3 Subjective Evaluation

The subjective evaluation was conducted by six men in their 20s with normal hearing using the recorded audio data. The two evaluation items were "noise comfort" and "speech intelligibility". Both of these two items were rated on a 5-point scale. In both cases, the higher the score, the better the evaluation. The average score of each evaluation result is shown below, and a discussion is given for each noise level magnitude.

3.1 Results of 60 dB (Noise Level)

Figure 3 shows the evaluation results when the noise is 60 dB, a case where the noise is smaller than the conversational speech. It can be seen that each external microphone is independent of its position, has the same amount of noise, and does not change significantly in speech intelligibility. In this case, it can be seen that the audio data is highly dependent on the performance of the microphone. However, the main microphone is slightly more difficult to hear conversations than the external microphone. Therefore, it is considered effective to combine audio data from the main microphone and external microphone for noise suppression. In this case, the position of the external microphone does not seem to be that important.

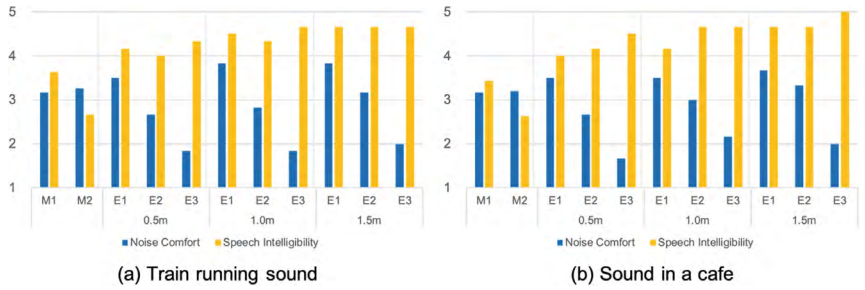


Fig. 3. Evaluation results of 60 dB(noise level)

3.2 Results of 70 dB (Noise Level)

Figure 4 shows the evaluation results when the noise is 70 dB, a case where the noise is almost the same level as conversational speech. It can be seen that as the external microphone gets closer to the conversational partner, the effect of noise becomes smaller and the hearing of conversational speech improves. At the main microphone, the noise influence is quite large, and listening is clearly more difficult than at the external microphone. Therefore, if the noise is as loud as the conversational speech, the closer the external microphone is to the conversation partner, the more effective it is to combine the two for noise suppression. In this case, the closer the position of the external microphone is to the conversation partner, the greater the difference between the audio data from the external microphone and the main microphone. Therefore, it is considered to be effective to combine the two audio data for noise suppression.

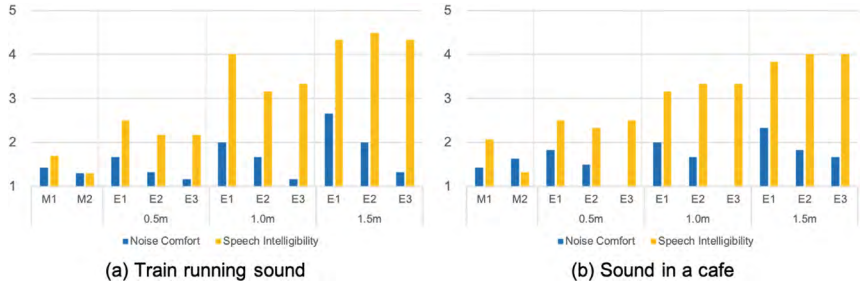


Fig. 4. Evaluation results of 70 dB (noise level)

3.3 Results of 80 dB (Noise Level)

Figure 5 shows the evaluation results when the noise is 80 dB, a case where the noise is louder than the conversational speech. In this case, all microphones were affected by the noise regardless of their position. As for speech intelligibility, in the case of train running sound, the main microphone can't hear conversational speech at all, and the external microphone has difficulty hearing conversational speech regardless of the

microphone position. In the case of sound in a cafe, if the external microphone is close to the conversation partner, the conversational speech can be heard slightly, but in other positions or with the main microphone, the conversational speech will be much harder to hear. Therefore, if the noise is louder than the conversational speech, it is considered effective to combine the two for noise suppression, because a position of the external microphone close to the conversation partner will cause a big difference in the audio data from the main microphone.

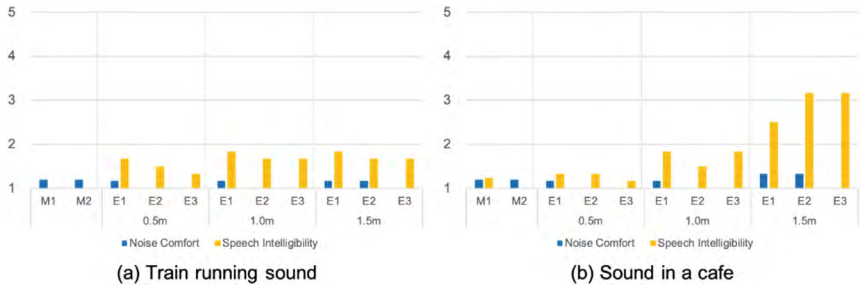


Fig. 5. Evaluation results of 80 dB (noise level)

3.4 Results in Each Microphone

The following is a discussion in terms of the type of microphone used in this study. As for the main microphone, there was no significant difference in terms of noise impact. However, M1's built-in hearing aid microphone was superior to M2's earphone-type microphone when it came to listening to conversations. Also, M2 has the most listening issues among the microphones used in this study.

As for external microphones, E3's smartphone built-in microphone, E2's omni-directional condenser microphone, and E1's unidirectional condenser microphone, in that order, are less susceptible to noise. In addition, E1 had the smallest noise effect among the microphones used in this study. As for listening to conversations on external microphones, there was little effect of the type of microphone. Therefore, we can say that the directionality of the external microphone suitable for the system proposed here is unidirectional. In addition, the smartphone's built-in microphone, which is the most familiar microphone, was more susceptible to noise than other microphones, but was able to hear speech well. For this reason, it is also effective to use the built-in microphones of smartphones in the proposed system. In addition, as the noise became louder and the distance between the main microphone and the external microphone increased, the difference in hearing the audio became larger.

4 Conclusion

When a hearing aid is used in a noisy environment, it is susceptible to noise because the built-in microphone of the hearing aid alone is used to capture voice. The ultimate goal

of this research is to develop a system that efficiently suppresses noise entering a hearing aid by combining multiple microphones located at different positions from the hearing aid. As a preliminary step in building this system, in addition to the hearing aid's built-in microphone, we placed several microphones between the subject and the person with whom he was speaking, recorded under various conditions, and evaluated the differences. In the experiment, main microphones and external microphones were evaluated for noise impact and speech intelligibility on a five-point scale. As a result, the evaluation items were scored approximately up to two levels higher, and the external microphone reduced the effect of noise and improved listening comprehension. Therefore, the use of external microphones may solve the problem of hearing aids that have challenges in using them in noisy environments.

For future work, it is necessary to actually construct the proposed system and perform noise suppression by combining sound data from multiple microphones. Furthermore, it is necessary to evaluate the effectiveness of its system in a real environment.

Acknowledgments. I would like to express my deepest gratitude to Professor Yoshihisa Nakatoh for his guidance and encouragement in conducting this research.

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Determination of the Stressed State of a Person by the Method of Pupillography

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Abstract. The purpose of the work is to identify the stressed state of a person and compare the results obtained by measuring the galvanic skin response and the pupillography method. Within the framework of the work, a pupillographic module for registering changes in pupil size, a hardware-software complex "Activatiometer-6" is used. Before the experiment, we created a situation that was a source of stress. With the help of an optoelectronic system, a video recording of the movement of the pupil was made. In this case, before and after diagnostics were carried out on the device "Activation-6". The difference between measurements on the device "Activatiometer-6" before and after exposure to stimuli is an indicator of the stress state. In combination with other methods (eye-tracking, vibro-image), it is possible to carry out remote diagnostics of the stress state.

Keywords: Stress · Pupillography · Galvanic skin reaction

1 Introduction

The modern pace of life often puts people under stress. In order for the stress state not to take extreme forms, timely diagnostics are needed. Express diagnostics of stress includes various questionnaires, questionnaires, scales aimed at determining the levels of anxiety and depression (Zung Self-Rating Depression Scale, Beck Questionnaire, Wakefield Self-Assessment Depression Inventory, Hospital Anxiety and Depression Scale, Hamilton Rating Scale for Depression, Spilberger Anxiety Inventory).

Sulaiman N. et al. [1] present new methods for extracting signs of stress from electroencephalogram signals during two cognitive states: closed eyes and open eyes using relative energy ratio (RER), Shannon entropy (SE) and spectral centroids (SC).

Yumatov E.A., Sudakov K.V., Tarakanov O.P. [2] developed a method for identifying emotional stress and a device for its implementation. The method is based on the registration of vegetative parameters of a person (heart rate and respiration, galvanic skin resistance) and on the calculation of cross-correlation coefficients, the values of which determine the degree of stress development. The stress detection device is intrusive and people are not very uncomfortable wearing it in their daily life.

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 938–945, 2022.
https://doi.org/10.1007/978-3-030-85540-6_119

Seo W. et al. [3] propose a new stress detection algorithm based on end-to-end deep learning using multiple physiological signals such as electrocardiogram (ECG) and respiration signal (RESP).

Cho et al. [4] have proposed a promising approach to stress recognition using a cheap thermal imaging camera. SCWT and Mental Computation Tests were used to stress the participants in the lab room. The collected thermal images of human respiration were pre-processed to create spectral sequences, and then CNN was used to extract features from them. The proposed CNN achieved, on average, over 80% accuracy for classifying images as tense or non-tense.

One of the most common and accessible methods for detecting stress is the measurement of galvanic skin response.

The purpose of the work is to identify the stressed state of a person and compare the results obtained by measuring the galvanic skin response and the pupillography method.

2 Experimental Methods and Techniques

Measurement of the psycho-emotional state was carried out using an activatiometer that registers galvanic skin response (GSR). A feature of the device is its increased accuracy and sensitivity. In addition, it allows one to take into account the contribution of activation of each hemisphere to the general psychoemotional state.

When measuring galvanic skin response, it is necessary to ensure that the measurement conditions are as similar as possible. To do this, all participants washed and dried their hands with disposable towels before measurements. The unification of the clamping of the plate electrodes is ensured by standard spring loading. Each of the four plate electrodes is placed on a special substrate equipped with four standard springs. When pressed, the substrate is recessed to a standard depth, which signals that the pressure is sufficient.

The diagnostic procedure on the "Activationometer" device is as follows. The subject firmly presses the right and left pairs of plate electrodes with the palms of both hands (Fig. 1). In this case, the location of the palms of the hands relative to the electrodes should be symmetrical; the electrodes should be pressed against the convex parts of the palms. In this case, the bones under the bases of the fingers on the back of the hand will be above the middle of the upper plate electrode. Also, the plate electrodes must be pressed against the stop. The subject must press on the electrodes for 2–5 s. If the indicator arrow deviates to the right for the last division of the scale ("off-scale"), then it is necessary to weaken the signal level 3 times by pressing the 1/3 attenuator (divider) button. If the "off-scale" continues, then release the 1/3 button and press the 1/6 button. In this case, the signal is attenuated 6 times. In this case, when entering the results into the table, it is necessary to multiply the obtained values by the signal attenuation coefficient (by 3 or by 6). It is necessary to carry out measurements 10 times for further calculation of the average.



Fig. 1. Diagnostic procedure on the device model "AC-6".

After this procedure, using an optoelectronic system (Fig. 2), a video recording of the movement of the pupil is made.



Fig. 2. Optoelectronic system for registering changes in pupil size.

The subject sits on a chair, a special helmet is put on, which creates a rigid coordinate connection between the head and the video camera. Then the subject looks at the TV screen (located on the wall), from which the stimulus material is shown. In this case, the distance from the chair to the wall is at least two meters. Since all subjects have different physiological characteristics, it is necessary to adjust the angle of the video camera in accordance with each person. The procedure for obtaining pupillograms takes no more than 10 min.

The experiment was carried out with the consent of the participants. A total of 50 people, aged 17 to 35, took part. Attended by representatives of the male and female sex, representatives of different nationalities. All subjects did not have eye diseases or their vision was corrected (glasses, lenses).

The analysis of the obtained results was carried out in two stages. Dissection of images, processing and contouring of pupils was carried out using the ImageJ program [5]. The results were visualized using the OriginLab19 program.

To unify the diagnostic procedure, each subject is presented with the same stimulus material in terms of content, color, size, etc. The subjects were asked to watch a presentation consisting of calibration slides and stimuli (images). The last slide of the presentation featured a photo of a young man. Before the experiment (a few days or hours), this young man went into the student's office during the educational process, when the teacher left the classroom, in order to correct the mark in the teacher's journal (this action was previously agreed with the teacher). Later, after the experiment, the participants were asked the question: "Have they ever met this person?" In this case, the subject presses the right and left pairs of plate electrodes with the palms of both hands. If the indicators begin to increase when answering the question, then the subject begins to get nervous, then he is lying.

3 Results

The activator allows you to register the slightest changes in the psychoemotional state under the influence of various influences. As you know, the situational indicator reflects the level of psychoemotional tone (tension), the level of psychoemotional state (PS) in a particular situation. The results of measurements of 43 participants are shown in Fig. 3.

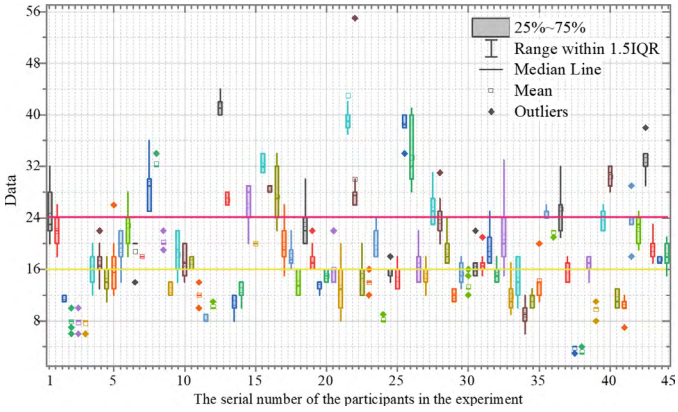


Fig. 3. Statistics: grouped box charts - raw data galvanic skin response.

When analyzing the measurements, we proceeded from the following logic. All participants in the experiment were exposed to the same visual information stimulus. Among the participants in the experiment were two categories of people. People from the first category were present and observed the attempt of the young man to correct the mark in the teacher's journal. People from the control group did not see anything and were not present (5 people). The stimulus material contained a photograph of a young man that the students should have recognized. Since the students concealed from the teacher the fact of an attempt to make corrections in the journal, they were in a tense state. Confirmation is the excess of the situational indicator over the individual typological in excess of the norm. The level of "excessive", corresponding to the standardized indicators

on the diagnostic scale of psychoemotional states in Fig. 3 is marked with a red line. Above average level is shown with a yellow line. However, students might simply be worried about the measurement procedure itself. Therefore, it is necessary to measure precisely the magnitude of the effect of the stimulus material on the subject. In this regard, measurements of the situational indicator of PS were carried out before and after exposure to test objects. If the subject's stress state increased, then the situational indicators increased. For additional confirmation of the results, at the very end, the question was asked "Have you ever met the person in the last photo?" In this case, the subject kept his hands on the plates of the activatiometer, and GSR was measured directly during the comprehension of the question asked and a few seconds after it.

The general emotional state of all participants in the experiment can be assessed by the average value of the individual situational indicators of the subjects. Comparative analysis of the results of measurements carried out before (A) and after (B) stimulus exposure is presented in Table 1. It turned out that the average value of the situational indicator decreased. It is logical to assume that the stress state in excess of the norm is due to the measurement procedure, and not to the effect of stimulus material.

Table 1. Compare means.

Descriptive Statistics						
VAR	N	Mean	Std Dev	Variance	Minimum	Maximum
24.4 (1)	43	19,9814	8,5131	72,4735	3,8	43,
22 (2)	43	16,8233	7,016	49,2237	3,2	33,4
Means Report						
VAR		Mean		99.9% LCL		99.9% UCL
24.4 (1)		19,9814		15,3885		24,5742
22 (2)		16,8233		13,0381		20,6084
Mean Difference (1-2)		3,1581		0,5552		5,7611
Paired two-sample t-test						
Hypothesized Mean Difference					0,	
Mean Difference					3,1581	
Variance					60,8486	
Pearson R					0,8239	
Test Statistic					4,2924	
Degrees of Freedom					42	
H1: Mu1 - Mu2 • 0 / Not equal (two-tailed)						
t Critical Value (0.1%)	3,5377	p-value	0,0001	H1 (0.1%)	Accepted	
H1: Mu1 - Mu2 < 0 / Less than (lower-tailed)						
t Critical Value (0.1%)	-3,296	p-value	0,9999	H1 (0.1%)	Rejected	
H1: Mu1 - Mu2 > 0 / Greater than (upper-tailed)						
t Critical Value (0.1%)	3,296	p-value	5,0954E-5	H1 (0.1%)	Accepted	

However, in 15% of the subjects, the situational indicator (stress state) increased. It was these students who were affected by the stimulus material, so it makes sense to compare the pupillary response in these cases.

As an example, Fig. 4 shows the pupillograms of two students (№ 1 and № 2). One of them (Fig. 4a) had the following indicators (Table 2).

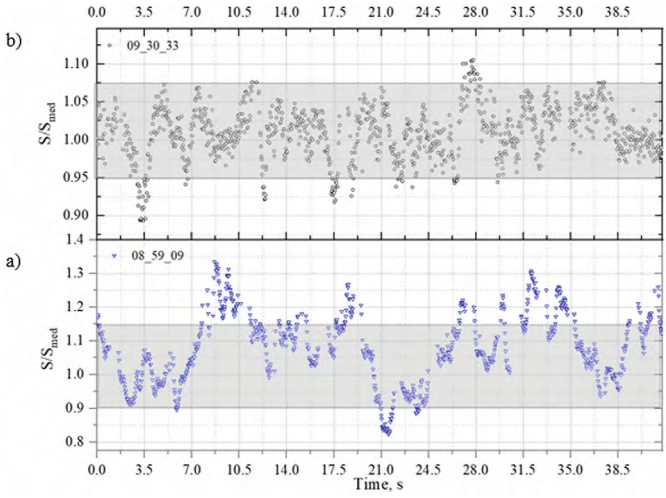


Fig. 4. a) Pupillogram with emotional response (lower); b) a pupillogram without an emotional response.

Table 2. Indicators of stress state for students № 1 and № 2.

Before the impact of incentives										
№1	14	13	12	13	14	13	12	11	12	12
№2	22	22	24	18	18	18	18	18	17	16
After exposure to incentives										
№1	16	16	16	14	14	15	14	15	14	15
№2	8	8	8	8	8	8	8	8	8	8

The indicator of tension of students № 1 and № 2 during the question is 20–28, and 8, respectively.

An oral survey confirmed that the first student recognized the person in the photo making an attempt to correct the grade. In addition, he pointed out the slides that elicited an emotional response from him. Pupillogram areas caused by emotions go beyond the gray zone. That is, the stressful state increased in the process of exposure to stimuli. The effect of enhancing the emotional state was observed both during repeated measurements and during the answer to a direct question.

The second student said that he did not feel any emotions, he had never seen the person in the photo. In his pupillogram (Fig. 4b), the change in the size of the pupillary reaction does not go beyond the calibration zone. Also, the level of emotional stress after exposure to the stimulus material did not increase.

For some students, an emotional outburst was observed on the pupillograms, but during repeated measurements there was no situational indicator. At the same time, the student calmly stated that he had seen the person. The situational indicator of such students was within the normal range.

Thus, the stress state determined by GSR is also revealed on the pupillograms. At the same time, after the decision is made, the tension subsides, the pupillograms and GSR return to normal.

4 Main Conclusions

Experiments were carried out to determine the stress state by two methods: measurement of galvanic skin response using the "Activatiometer-6" and by the method of pupillography. The results obtained were compared. The difference between measurements on the device "Activatiometer-6" before and after exposure to stimuli is an indicator of the stress state. The results obtained by the pupillographic method are consistent with the results of GSR measurements:

- Pupillograms of people whose level of psychoemotional state increased after exposure to stimuli, contained emotionally colored areas;
- If the decision to talk about the incident was made during the stimulus exposure, then the activiometer did not register an increase in the GSR signal.
- In the pupillograms of people from the control group, there was no increase in amplitude beyond the calibration zone. Those. the stress state was not registered either by the pulographic module or by the "Activatiometer-6".

Thus, pupillograms can become a non-contact means of measuring the stress state. Since GSR and pupil size are correlated, the pupillary response can be used in security systems in which observation must be unobtrusive (hidden).

Acknowledgments. The study was carried out with the financial support of the Russian Foundation for Basic Research in the framework of the research project 18-47-860018 p_a.

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Examination of Balance Adjustment Method Between Voice and BGM in TV Viewing

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Abstract. As the elderly age, their hearing deteriorates and it becomes difficult to hear the sounds of daily life. Especially, "TV sound" is hard to hear for one in two elderly people. The cause is that the voice is drowned out by the BGM. In this research, we focus on the volume balance between voice and BGM in TV sound, and propose a volume balance adjustment method using sound source separation technology as a method to adjust these appropriately. In addition, the effectiveness of the proposed method will be evaluated through subjective evaluation. In order to improve your hearing of TV sounds, you need to emphasize them. Therefore, in this research, we propose a method to emphasize the sound by separating the TV sound into voice and BGM by the sound source separation technology, suppressing the gain of BGM, and then reintegrating it. In this study, Spleeter is used. Spleeter is a sound source separation software that uses supervised deep learning. It is mainly used to separate songs into parts, and the input music data can be divided into parts (Example: Vocal/Accompaniment). In the experiment, we used a mixture of voice and BGM as the sound of the TV. (We have prepared two types of voice, "Natural voice" and "Whispering voice".) This simulated data is separated by Spleeter, and the gain of the BGM after separation is suppressed and mixed again. Eight male subjects in their twenties will be asked to hear the sound before and after processing to evaluate whether the ease of hearing the voice can be improved. As a result, it was found that increasing the ratio of voice improves the ease of hearing the voice. However, it was also found that the distortion generated in the process of sound source separation also affects the sound quality. Therefore, it can be said that it is necessary to improve the accuracy of sound source separation in order to further enhance the effect. In this study, we proposed a method to adjust the volume balance between voice and BGM to an appropriate level using sound source separation technology. In the future, we would like to consider ways to further improve hearing by improving the accuracy of sound source separation.

Keywords: TV · Elderly · Voice · BGM · Sound source separation · Spleeter

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 946–953, 2022.
https://doi.org/10.1007/978-3-030-85540-6_120

1 Introduction

As the elderly age, their hearing tends to decline [1]. This means that the sounds of daily life also become more difficult to hear. In particular, the sound that the elderly find most difficult to hear in their daily lives is the sound of TV, which accounts for 49.4%, or about one in two elderly people find it difficult to hear [2]. The causes are related to the content of the TV sound, such as "inability to hear the TV sound at normal volume depending on the program or content" or "inability to hear the speaker's voice well, especially when there is music or environmental sound playing in the background". For example, in a quiet conversation scene in a TV drama, the speaker's voice is often a whisper, and many people find it difficult to hear. Also, in order to create a sense of realism, intense BGM is used, which can drown out the voice. In other words, the volume balance between voice and BGM has a significant impact on the ease of listening. Therefore, in this study, we focus on the "volume balance of voice and BGM" and propose a method to adjust them to an appropriate level. Then, we evaluate the effectiveness of the proposed method through subjective evaluations.

First, here are some of the conventional approaches to hearing TV sounds. The speed at which the speaker speaks is a problem for the elderly in watching TV. For this reason, NHK has developed a device that can adjust the speed of speech on TV in real time [3]. This adjusts the speech duration while maintaining the fundamental frequency of the voice, thereby changing the speaking speed while maintaining the height of the voice. In addition, the delay can be eliminated by removing the silence section after slowing down the speed of the voice. Thus, it is possible to match the beginning of the next speech. Other than that, to address the problem of BGM making it difficult to hear the speaker's voice in sports programs and quiet drama scenes, NHK has been working on emphasizing the voice that is drowned out by the BGM by lowering the gain of BGM in the TV sound [4]. This method uses stereo correlation [5], where the TV sound is separated into voice and BGM, and the voice is emphasized by adjusting the gain of these two. Another method of separating TV sounds into and voice BGM is based on artificial intelligence: TOSHIBA estimates the source signals of BGM and voice by sequentially learning and updating the BGM information from the input signal [6]. It uses a source separation method that supplements a simple NMF [7] with the average spectrum of the training interval [8].

Next, we will introduce not only TV sound, but also voice enhancement techniques. There is an effort to improve the intelligibility of speech by emphasizing the formant frequency, which is a parameter that characterizes voice [9]. In addition, there is a method of extracting and emphasizing specific speech sounds from a mixture of multiple sound sources by source separation [10].

2 Proposed Method

TV sound is largely composed of voices and BGM, and it can be said that the audibility of TV sound can be improved by improving both of them. In methods that emphasize the audio band of TV sound, such as formant enhancement, the BGM is also emphasized at the same time. Therefore, we thought it would be best to separate the TV sound into its

constituent parts, voice and BGM, and process them separately. Therefore, we decided to use a sound source separation technique to separate the multiple sound sources. For this purpose, we decided to use Spleeter [11], which is a free and open source program that can be easily used by anyone to reproduce the experimental environment. In this study, we decided to use Spleeter without re-training, in order to investigate its separation accuracy for TV sounds.

2.1 Speech Enhancement Using Spleeter

Figure 1 shows a block diagram of the proposed system. First, we input the TV sound that is difficult to hear voice into the Spleeter, which separates the input TV sound into audio and BGM. Next, adjust the gain of the BGM. Finally, the BGM and the separated audio are recombined to create a TV sound with enhanced voice. In this study, the gain adjustment of the BGM and the integration of the BGM and voice were done using Audacity [12], an audio editing software.

In this study, we input a mixture of sounds that simulate TV sounds that are difficult to hear voice into our proposed system, and evaluated how much the output data makes the speech easier to understand compared to the data before the input.

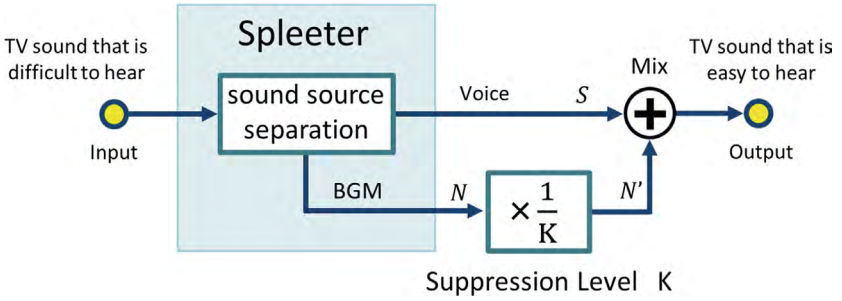


Fig. 1. A block diagram of the proposed system

2.2 Spleeter

Spleeter is an open source software released by Deezer, a music distribution service. It is a sound source separation software using supervised deep learning, and it is good at separating songs by parts. The learning method is to prepare an original song with vocals and an instrumental version of the song without vocals, compare them, and estimate the voice density of the vocals to train a deep neural network. The source code of Spleeter can be easily executed in a browser by using Google Colaboratory [13]. Therefore, we decided to use Google Colaboratory to use Spleeter in this study. Figure 2 shows a schematic diagram of Spleeter's source separation.

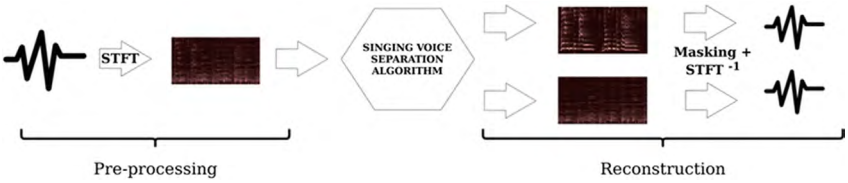


Fig. 2. A schematic diagram of Spleeter's source separation

3 Experimental Conditions

3.1 Simulation Data

The TV sound used in this study is a mixture of two separately prepared sound sources (voice and BGM). The BGM data was downloaded from a free sound source site (DOVA-SYNDROME) [14] and down-sampled from 44.1 kHz to 16 kHz. The voice data was prepared by recording the speaker's voice. At the time of recording, the sampling frequency was 48 kHz and the quantization bit rate was 16 bits. This was down-sampled to 16 kHz. The types of voice to be targeted are the "Natural voice" used in mainstream TV voices and the "Whispering voice" used in dramas. In this study, we decided to use speech uttered by a single male speaker in the "Natural voice" and the "Whispering voice". The text to be read out was chosen to be the ATR phoneme-balanced 503-sentence A-set "Bukka no hendo wo kouryoshite kyufusuijun wo kimeru hitsuyo ga aru", (It is necessary to decide the level of benefits in consideration of price fluctuations) [15]. From the preliminary experiment, it was determined that the mixed sound, in which the gain of the BGM was 7 dB higher than that of the voice, was the most difficult for the subjects to hear the voice. Therefore, for the simulated data used in the experiment, we decided to use a mixture of sounds in which the gain of the BGM was adjusted to be 7 dB higher than the gain of the voice. Figure 3 shows the flow of creating the simulation data.

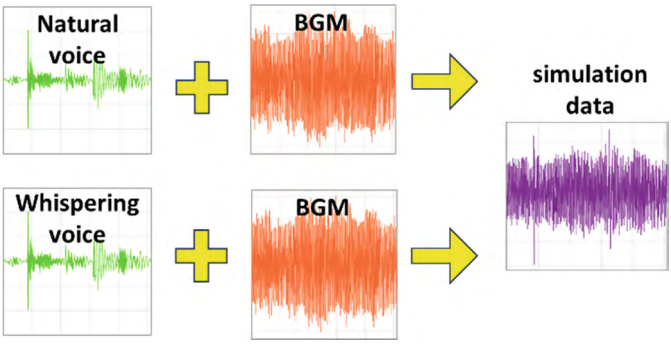


Fig. 3. The flow of creating the simulation data

3.2 Evaluation Method

The simulated data is input to the proposed system, and the system outputs data in which the voice is emphasized. This data is used as the evaluation data, and by comparing the simulated data with the evaluation data, we evaluate the improvement in the audibility of the TV sound. In this research system, we prepared seven patterns for adjusting the gain of the BGM: "−7 dB", "−5 dB", "−3 dB", "0 dB", "+3 dB", "+5 dB", and "+7 dB".

As for the subjects for the subjective evaluation, this study was intended for the elderly, but it was difficult to invite subjects from outside the college due to COVID19. Therefore, we conducted the experiment with our students (8 males in their 20s). The experiment was conducted in a soundproof room on the third floor of the Education and Research Building No. 5, Faculty of Engineering, Kyushu Institute of Technology.

The following is an explanation of the subjective evaluation method. The subjects wore headphones (audio-technica ATH-AVC300) and were asked to evaluate the mixed sound played by a notebook computer (FUJITSU LIFEBOOK A77/C2). First, they listened to the simulated data as the reference sound, and then compared it with the prepared seven types of evaluation data. At that time, they are asked to evaluate the following three things.

1. The loudness of BGM relative to voice
2. The voice intelligibility
3. The sound quality

For each question, the participants were asked to rate on a five-point scale: "Much better," "Slightly better," "No change," "Slightly worse," and "Much worse". After these evaluations were made for the Natural voice mixture, the Whispering voice mixture was evaluated in the same way. Each data can be listened to again and again until the evaluation is determined. Figure 4 shows the flow of the subjective evaluation.

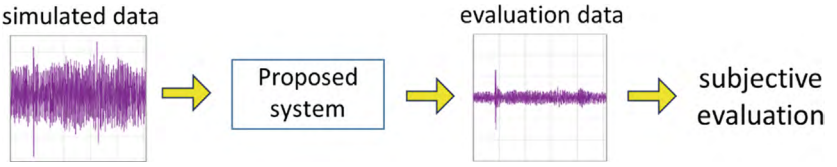


Fig. 4. The flow of the subjective evaluation

4 Experimental Results

The results of the subjective evaluation are shown below. Figure 5 shows the evaluation result of the loudness of BGM relative to voice. Figure 6 shows the evaluation result of the voice intelligibility. Figure 7 shows the evaluation result of the sound quality. The mean evaluation value and its transition, interquartile range, and maximum and minimum values for each result are shown in box plots, respectively. The evaluation

values mean the following “2: Much better”, “1: Slightly better”, “0: No change”, “−1: Slightly worse”, and “−2: Much worse”. In Fig. 5, the average evaluation value shows that the evaluation of the loudness of the BGM to the voice is improved by increasing the SNR for both the Natural voice and the Whispering voice. We think this is because the Spleeter can separate the mixed sound into voice and BGM, and by lowering the level of BGM, the intelligibility of the voice increases. In Fig. 6, the average evaluation values show that as the SNR is increased for both the Natural voice and the Whispering voice, the audibility of the voice is also improved. The higher the SNR, the more the evaluation results varied. In Fig. 7, we can see that as the SNR is increased, the evaluation of the sound quality becomes worse for the Natural voice. This means that the number of people who felt the deterioration of sound quality increased. In addition, the evaluation results varied. On the other hand, the whispering voice showed almost no deterioration in sound quality when the SNR was increased.

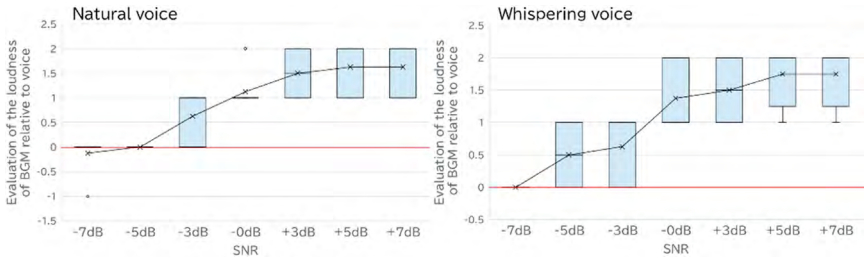


Fig. 5. The evaluation result of the loudness of BGM relative to voice

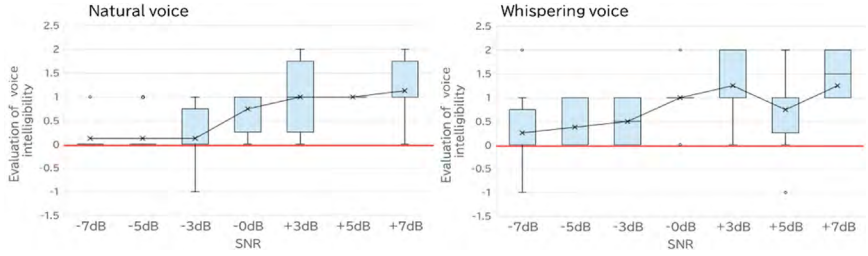


Fig. 6. The evaluation result of the voice intelligibility

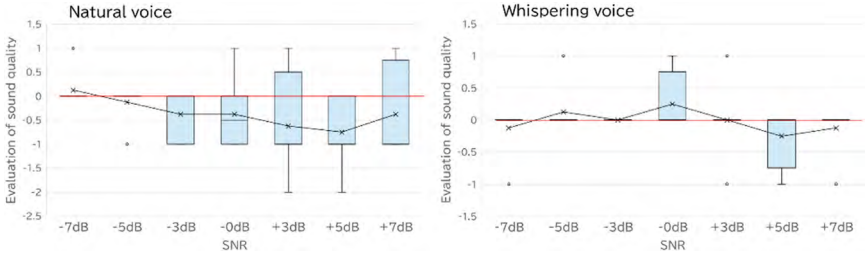


Fig. 7. The evaluation result of the sound quality

5 Consideration

The experimental results show that the higher the SNR is, the more the evaluation results vary. This is thought to be related to the accuracy of the source separation by Spleeter. Figure 8 shows the waveforms of the original voice data and the voice data after separation by Spleeter. It can be seen that before and after sound source separation by the Spleeter, a part of the voice may be judged as BGM and cannot be separated properly. As a result, the sound quality of the voice changes, and the change in sound quality is noticeable when the SNR is increased, and the evaluation is divided between those who are bothered by it and those who are not.

In addition, the Whispering voice, unlike the Natural voice, showed almost no deterioration in sound quality even when the SNR was increased. This is because when BGM was added, the Whispering voice was strongly drowned out by the BGM and it was more difficult to perceive the change in sound quality than the Natural voice.

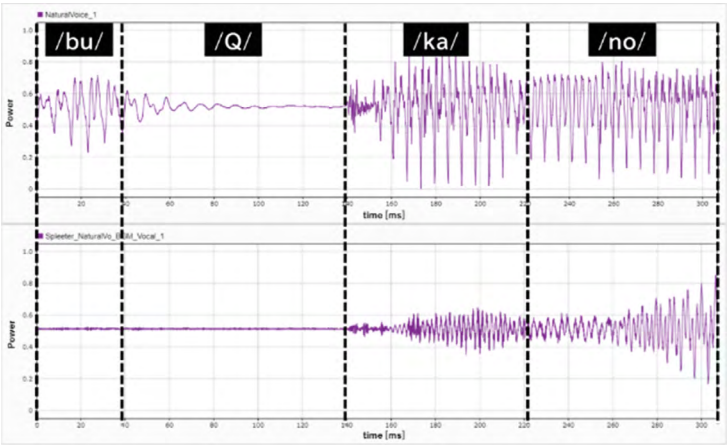


Fig. 8. The waveforms of the original voice data (above) and the voice data (bottom) after separation by Spleeter

6 Conclusion

From the evaluation results, it was found that the sound source separation technique by Spleeter is effective as a method to adjust the volume balance of voice and BGM in a mixture to an appropriate level. However, the changes in sound quality that occur during the sound source separation process can interfere with the hearing of the voice. Therefore, it is necessary to improve the accuracy of the sound source separation in order to enhance its effectiveness. In this study, the evaluation experiments were conducted on young people, but it is necessary to conduct subjective evaluation on elderly people in the future. In addition, we would like to study how to improve the sound quality by improving the accuracy of sound source separation.

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Low-Cost Portable System to Support People with Visual Disabilities

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Abstract. The main goal of this work is to present a wearable device to assist the visually impaired. This device brings help in navigation and reading tasks, keeping a low-cost, and without an internet connection. The main technologies integrated are Object Detection, Optical Character Recognition (OCR), Text to speech (TTS), and Speech Recognition. It uses a Raspberry pi 3B and complementary accessories in order to accomplish this task. To customize object detection, a SSD MobileNet V2 FPNLite 320 × 320 was re-trained, with images from a public dataset mixed with own images.

Keywords: Wearable system · Object detection · OCR · TTS · Speech recognition

1 Introduction

Assisting the blind and visually impaired has been a challenging task with lots of efforts made during the last years. This group of persons normally use all the other senses, white canes and guide dogs. However, there still are situations where they have many difficulties, such as reading, location of an address, shopping (names, color, and prices), etc. So, they usually need to ask for help when they arrive in an unfamiliar indoor space [1].

In the last two decades, systems with different types of sensors and information transmission have been made to assist the daily life of this population [2, 3]. A wide field of research is vision-based systems [4–7]. In [8], a wearable speech-based device with a Raspberry Pi is used to allow to read and detect objects using a YOLO pre-trained model.

The objective of this work is the development of a system that combines object detection, OCR, text to speech, and voice recognition to assist the visually impaired in the daily tasks of navigation and lecture.

1.1 Object Detection

Object detection is a computer vision technique that allows machines to identify and locate objects in an image or video. A wide variety of algorithms have been developed to do this task [9], however, CNNs have become more popular since AlexNet [10] won

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 954–960, 2022.
https://doi.org/10.1007/978-3-030-85540-6_121

the ImageNet challenge ILSVRC 2012. An exhaustive literature review of CNNs for object detection is available in [11].

Though CNNs based models have improved accuracy in popular standard datasets, as COCO and PASCAL, those improvements have been achieved with deeper models and computationally expensive operations. In [12], an experiment to compare different object detection metrics in a wide variety of meta-architectures and feature extraction combinations is designed. In this work the SSD-MobileNet is used because it is a good option for real-time applications.

In recent years, Tiny Machine Learning has explored new strategies to reduce even more model sizes. The main advantages of Tiny Machine Learning approaches are lighter and faster models, energy efficiency and cloud independence (privacy of users' data) [13]. Some of these techniques, applied to Neural Networks, are proposed in [14] and [15].

1.2 OCR

Optical character recognition (OCR) is the computerized conversion of texts that come from different sources like printed texts, natural images or handwritten documents [16].

There are plenty of OCR engines available and the choice of one of them depends on the kind of application, the language, the OS where it will be used, and more [17]. Version 4.0 of Tesseract, which has incorporated LSTM (Long Short-Term Memory) technology, showed to be more accurate in low-resolution images in comparison with version 3.5 [18]. Also, the construction of Raspberry pi-based OCR systems to assist the visually impaired have been explored recently [19, 20].

An OCR Framework typically has the following steps: image acquisition, preprocessing, segmentation, feature extraction, classification and post processing [16]. In order to get higher recognition rates, there are some preprocessing techniques that improve the details of the image, such as noise removal, image sharpening methods, deskewing methods, etc. Some of these useful techniques were explored in [18, 21, 22] and [23].

2 Methodology

2.1 Dataset

The Dataset is composed of some images of the MCIndoor2000 Dataset [24] and some photos corresponding to 7 different classes. Among them Colombian currency (bills), signs, and doors. It was divided as follows: 90% of the images are in the training set and 10% in the test set. After this, a data augmentation step was done in the training set as follows:

1. Transformation 1: It is a 90° clockwise rotation and an image smoothing (kernel size (7, 7)).
2. Transformation 2: It is a 180° clockwise rotation and an image sharpening.

2.2 Training

The CNN architectures tested were improved versions of MobileNetV2, called MobileNetV2FPN [25], available in the Tensorflow 2 Object Detection API. The following are the specific architectures tested:

1. SSD MobileNet V2 FPNLite 320 × 320.
2. SSD MobileNet V2 FPNLite 640 × 640.

2.3 Validation

To understand the metrics used in this work to evaluate object detection the definitions in Eq. 1 are needed.

$$Precision = \frac{TP}{TP + FP} \qquad Recall = \frac{TP}{TP + FP}. \tag{1}$$

Where TP, FP, and FN mean the number of true positives, false positives, and false negatives detected.

$$IoU = \frac{Area\ of\ Overlap}{Area\ of\ Union}. \tag{2}$$

IoU (Eq. 2) is defined as the area of the intersection (overlap) divided by the area of the union of a predicted bounding box. Fixing an IOU minimum value (0.5 is common), predictions are displayed when they surpass a minimum confidence score in a class. For this class, precision and recall are calculated in an accumulated way, so it is possible to plot a precision-recall curve. An approximation of the area under the curve of the precision-recall curve is called Average Precision (AP), see Eq. (3).

$$AP = \sum_{i}^{n} \quad (R_i - R_{i-1})P_i. \tag{3}$$

The mean Average Precision (mAP) is the average of AP in every class (Eq. 4).

$$mAP = \frac{1}{k} \sum_{i}^{k} \quad AP_i. \tag{4}$$

The main metric used in this work is the mean Average Precision from COCO, which is an average of a set of mean Average Precision with different IOU thresholds. See Eq. (5).

$$mAP_{COCO} = \frac{mAP_{0.5} + mAP_{0.55} + \cdots + mAP_{0.95}}{10}. \tag{5}$$

3 Proposed System

The system presented in Fig. 1 takes advantage of the object detector outputs to provide information about objects in front of the users when it is requested.

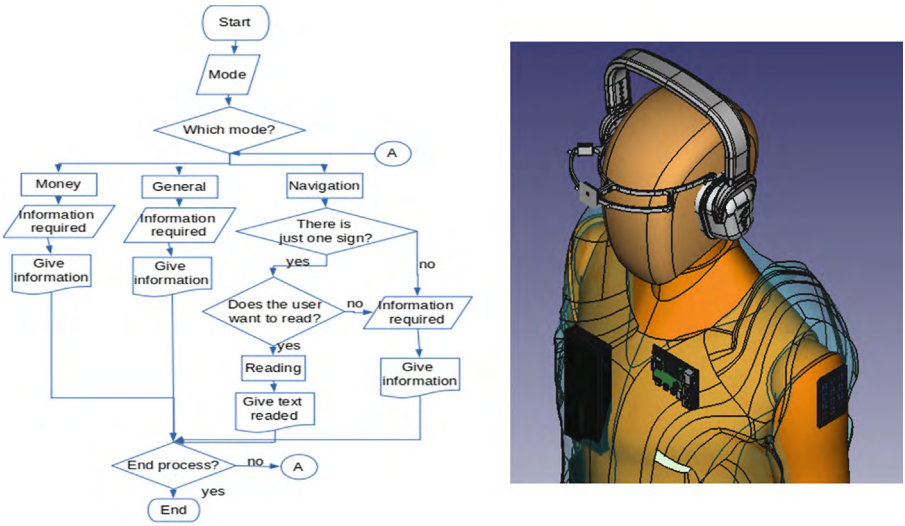


Fig. 1. Proposed system. Flowchart (*left*) and structure (*right*).

The user interface allows using voice commands (Pocketsphinx was used in this work) or buttons to select the following modes:

1. General mode: this mode informs whether there are doors, signs, or money and how many. The aim of this mode is to be the first the person uses.
2. Money mode: with this mode, the user can know the total amount of money and which type of bills there is.
3. Navigation mode: the user can switch between door information or sign information. The information generated approximates the position of the object. The reading function is available when the only object detected belongs to the sign class, then, the ROI that previously was found goes into an OCR process where the coordinates of the corners of that sign are located by a Canny edge detector. After the four corners are known the system performs and homography to deskew the image. Then the OCR engine (tesseract 4.0) returns a string data type with the read information. This string is taken from the TTS engine (eSpeak) to make a sound for the user.

4 Results

After the training process, the object detection models were converted to a TensorFlow Lite format using a 32 bits float format. Table 1 shows some hyperparameters and results. Since one of the models had an input 4 times bigger, it achieved a better accuracy (mAP). When the model with 320 $\times$ 320 input was tested, it worsened the accuracy, but also reduced the model size and improved the inference 3 times. This last model was selected for the system.

Table 1. Main features of the object detectors tested.

Model	Batch size	Iterations	mAP_{COCO}	FPS (Raspberry pi 3B)	Size (MB)
640 × 640	5	3000	0.83	0.4	5.8
320 × 320	8	4800	0.80	1.2	5.5

The reading function can give a good performance when the background is not too complex, and the bounding box reaches a minimum size. In Fig. 2 the main stages of the reading function are shown.



Fig. 2. Reading function. Sign detection (*left*), contour and corner detection (*center*) final image to read (*right*).

The system is equipped with speech recognition that allows it to take some predetermined keywords or phrases to change the modes and it is supported with buttons for cases when the user voice command fails, or their privacy is more important.

5 Conclusions

The selected architecture and methods have shown to be effective in the proposed tasks and suitable for real-time mobile applications. Since the software used for OCR, TTS, and Speech recognition is independent of the object detection solution, different options could be easily incorporated into similar applications that involve the above tasks. An important aspect of the developed system is that it is independent of an internet connection. It was trained with an own labeled dataset that can be extended according to the needs of the user. As future work, other methods of interaction will be incorporated into the system.

Acknowledgments. The authors would like to thank Universidad Militar Nueva Granada for the financing of the project INV ING 3198.

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Research Progress in 3D Modeling of Female Breast

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Abstract. In comparison with human body modeling, breast modeling requires more details. As we delve into relevant literature, we found that the mainstream approaches to human body modeling are curve modeling and hybrid modeling. Given the existed approaches to human body modeling, there are three ways to model the shape of breast, which are surface modeling, graphic modeling and finite element modeling. Though the main methods remain to be the surface modeling and graphic modeling, the finite element modeling, which is an emerging technology, has a promising future. Our paper expounds the application of parametric modeling, 2D image generation method and inverse modeling in virtual modeling. In the end, we conclude that inverse modeling is an effective and accurate method at present.

Keywords: 3D modeling · Breast modeling · Virtual clothing model

1 Introduction

Breast is an important part that reflects the beauty of women's curves. Studies have found that breast shape is affected by multiple factors, such as BIM value [1], age, breastfeeding [2], etc. Relevant studies have pointed out that the breast generally takes the shapes of dis, cone, hemisphere and so on. The traditional approach which describes the breast shape only by the difference between upper and lower bust circumference is no longer accurate [3, 4], so it is necessary to establish an individual breast model for deepgoing research. 3D human modeling has been a key technology in clothing digitization research for many years. Now researchers at home and abroad have explored well into the surface modeling, graph modeling, finite element modeling, and virtual fitting modeling. As a result, they have yield a host of efficiently methods in establishing individualized models.

This paper mainly analyzes the research status quo of female breast modeling and summarizes the progress and development trend of digital technologies involving 3D body modeling, 3D breast modeling and virtual fitting.

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 961–966, 2022.
https://doi.org/10.1007/978-3-030-85540-6_122

2 Research on 3D Human Modeling

At present, there are several methods to model human's body, such as wireframe modeling, solid modeling, surface modeling, hybrid modeling, etc. Wireframe modeling is the earliest modeling method in graphics modeling. It uses points, lines, surfaces and spline curves to construct objects [5], and it is also the basis for establishing the complex models. Solid modeling is a method which uses geometry and calculation to build models, and it can also construct the internal structure shape of objects [6]. Surface modeling is based on the relationship between curves, and is featured by high flexibility. Hybrid modeling is a mixed application of the above modeling methods.

The analysis points out that surface modeling is mainly based on NURBS curves. It is simpler, but not applicable to complex human morphology. Triangular mesh modeling often establishes more flexible model, yet it often requires much more time and energy when processing point cloud data.

3 Research on 3D Breast Modeling

For the reason that the chest is a part of the human body with large curvature changes, the chest modeling requires more detailed data than the human body modeling, and the modeling process is also more difficult. Based on methods of human body modeling, this section mainly introduces the major applications of surface modeling, graphic modeling, finite element modeling and virtual fitting modeling with regards to chest modeling.

3.1 Surface Modeling

Surface modeling refers to human body modeling based on modeling software. This method mainly uses 3Dmax, MAYA and other software to directly construct or modify the human body models in the model base. On the basis of the original polygon modeling, it involves other fitting curves like Bezier curve and NURBS curve, thus can effectively deal with the non-smoothness of the polygon model [7].

By means of 3D scanning on the human body, Xiaoxiao Gao collects point cloud data, then establishes a chest model by detecting curvature, constructing surface patches, constructing grids, and fitting curved surfaces to modify the NURBS curve model [8].

Yaoyao Xu directly scans the bra mold cup to obtain the mold cup structure line through reverse modeling, then she uses the inflection point and peak point of the curve to modify the shape of the mold cup and control the mold cup structure [9].

In summary, the operation process of surface modeling is relatively simple, requiring less point cloud data. So it is the preferred method to build the model. At present, NURBS is the widest used curve in surface modeling. It can quickly build accurate human table and chest models. However, due to the poor flexibility of the surface function relationship, it is often limited in the establishment of special body models.

3.2 Graphic Modeling

Based on the topological relationships among points, lines and surfaces, graph modeling constructs models by optimizing polygonal meshes. In this way, coupled with main

component weights of the human body shape obtained by linear regression analysis, researchers can acquire the all-sided, accurate characteristics of human body shape and establish a human body model with a mapping relationship [10]. Graphic modeling can control the model more freely, and modify the details on the basis of surface modeling to facilitate the establishment of a personalized 3D human body model.

Yi Xiu uses the double deformation axis to divide the complex bust line into several simple curves, transforms the shapes of simple curves at different positions by iterative initial axis and the angle weighted average principle [11], then combines several simple curve segments into a complex bust line to complete the curved surface deformation of the female body's chest model [12].

Michael W. Gopper uses the statistical shape model (SSM model) method and the studies on the volume of female breasts to instruct mastectomy and breast reconstruction surgery. In SSM modeling, researchers extract the breast data generated by reverse modeling and analyze principal components to restore the precise shape and volume of the missing breast. Compared to the original volume method, the breast edge and shape based on SSM modeling are closer to the patient's exact breast shape [13].

To sum up, Graphic modeling is more flexible in dealing with surface changes, and the model it established is closer to real human conditions. However, the method requires huge amounts of point cloud data as the basis for deformation, as well as more mathematical calculations to accurately control model changes. Therefore, it is a difficult approach with less efficiency.

3.3 Finite Element Modeling

Finite element models were widely used in industrial practice in the early days, and have emerged as a new approach in human modeling recently. The method is distinctive in that it incorporates conditions such as materials and constraints to realize dynamic changes of the model. When finite element method is adopted for breast modeling, the female breast can be regarded as an elastic body. And researchers can observe and simulate more breast movements by changing the material and force of the elastic body.

Joanne Yip adds gravity conditions, resistance conditions and partial displacements to the mesh finite element model to determine the appropriate breast coefficients and uses Mooney-Rivlin hyperelastic material model to build a finite element model of the chest. The model can capture the dynamic deformation of the chest when wearing a bra [14].

Yue Sun adds nonlinear breast material coefficients to the established breast model, and uses iterative changes to simulate the deformation caused by breast movement. Then the dynamic model of the breast was developed by using the hyperelastic material neoHookean to simulate the deformation of the breast during movement [15]. This method combines the static and dynamic finite element models of the breast for the first time. After model optimization, a new bra try-on system based on numerical simulation was established, which verified the rationality of predicting deformation and contact pressure by means of the finite element model [16]. Based on the above two studies, Ruixin Liang simulates the contact pressure between the bra and the body, compares the static contact pressure of different bras to verify the rationality of the model, and lays the foundation for future bra making [17].

Due to external factors such as gravity, environment and damping, finite element model can establish a chest model more in line with the actual situation. The key of the finite element modeling lies in the displacement when super elastic materials are simulating the movement of the breast. Relevant researches can not only be used to study the shape of the chest, but also provide a research basis for future research on chest pressure and bras-making.

4 Research on 3D Modeling of Female Breasts in Virtual Fitting

In the wake of the constant development of Internet technology, the rise of online platforms provided consumers with a more convenient way to shop. At present, most of the try-on effects provided on the platform are inconsistent with own information, resulting in the fact that the actual online transaction rate is not high. To solve this problem, the virtual fitting system appeared in the public eye. With the continuous advancement of virtual technology, personalized modeling has become a major research direction. This subsection focuses on the modeling technology of virtual fitting system, and mainly introducing the method of breast.

4.1 Virtual Fitting Introduction

Virtual fitting is to simulate the human body model and clothing fitting situation in a computer virtual environment. To this end, it mainly builds models through para - metric modeling, 2D image generation method, 3D scanning method and other methods. Compared with the 2D image method, parametric modeling has higher efficiency and accuracy. Human body modeling based on 3D scanning uses scanning equipment to scan the human body so as to obtain data and information on the surface. And then the human body model is reproduced through the processing of corresponding point cloud [18].This method has the merit of high stability and high accuracy.

4.2 Research on Female Chest Modeling in Virtual Fitting

Liwen Gu redevelops the control points of the characteristic surface of the human body model so that these points can move along the normal direction. In order to establish a human body model that meets the needs of virtual fitting to a greater extent, the author controls the front and rear control points of the bust section to eliminate the concave structure of the human body. This method meets the needs of different models in the parametric modeling of virtual fitting and improves the efficiency [19].

Jida Huang uses the analytic hierarchy process to correlate the parameters of adjacent parts. For example, when inputting waist data in the reverse model, the bust and hips will be corrected according to the waist data. This method combines the advantages of linear regression and grid subdivision to reproduce more human body information. It builds a more realistic model in personalized modeling and virtual fitting, and addresses some of the problems caused by extreme situations [20].

In conclusion, the most efficient method of breast modeling now is reverse modeling based on 3D scanning. It provides a large amount of details for breast modeling by

collecting a enormous chest data. It can also offer a more suitable human body model in virtual fitting software such as CLO3D in the future. Regardless of online or offline shopping, the emergence of virtual fitting technology has brought us great convenience. With the help of constant progress in the fitting model, consumers will enjoy a more personalized shopping experience with sense of science and technology.

5 Conclusion

This article studies the establishment of female breasts model, and summarizes the application of 3D human body modeling, breast modeling and virtual reality technology. As we finished our analysis, we found that most of the current chest models are based on human body models, which falls short of details. At this moment the breast model is generally built by curved surface modeling and reverse modeling. As an emerging technology, finite element modeling has great room for further development in breast modeling.

The breast is one of the parts of female body that has the greatest curvature changes, so it makes sense to build specialized models for it. In the future, researches on the shape of chest can be added to the breast modeling to make it more personalized. With the improvement of the models for virtual fitting and virtual fitting itself, it's possible that the fitting process in offline stores will be replaced and consumers will enjoy a better experience in online shopping.

Acknowledgments. This work was supported by the Ministry of Education Youth Fund for Humanities and Social Sciences [17YJC60096]; Liaoning Provincial Department of Education scientific research project [J2019023].

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Analysis of Secondary Education Services During the COVID-19 Pandemic

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Abstract. The research objective is to look at secondary education services during the COVID-19 pandemic to determine education services' effectiveness. The method in this research is Q-DAS (Qualitative Data Analysis Software) NVivo 12 plus. The research data use the Twitter social media activity of the Ministry of Education and Culture of Indonesia. Stages of data analysis with NVivo 12 plus data were taken, data import, data coding, data classification, and data display. The research results show that educational services during the COVID-19 pandemic in Indonesia are ineffective compared to conventional (face-to-face) learning. Online knowledge is only practical for giving assignments. The success of online learning during COVID-19 depends on all school parties' discipline by making schemes to compile good management in regulating the online learning system. Creating a systematic and straightforward schedule facilitates parent and school communication to monitor students effectively.

Keywords: Online learning · Covid-19 · Social media · Study from home

1 Introduction

The Indonesian government announced the first case of the coronavirus (COVID-19) in March 2020. Almost all sectors of life have been affected, including the education sector. COVID-19 has spread to all countries in the world, including Indonesia. The World Health Organization (WHO) made this outbreak a global pandemic on March 11, 2020 [1]. To reduce the spread of COVID-19, the government has implemented a social distancing strategy, one of which is by closing schools. The policies issued to limit the spread of the coronavirus impact various fields worldwide, especially in education [2].

Learning that should be done face-to-face turns to online learning. It aims to meet educational standards by utilizing information technology using computer devices or gadgets connected between students and teachers. Through these technologies, the teaching and learning process can be carried out properly, not bound by time and with this changing learning system. Bring a significant impact in the world of education [3]. Moreover, the corona pandemic's smash hit so that learning efficient because they had to stay at home and apply physical distancing [4]. Although there are many obstacles to their application

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 967–973, 2022.
https://doi.org/10.1007/978-3-030-85540-6_123

for teachers, students, parents and educational institutions, there is a research problem presented in this literature review: How can Indonesian education services be effectively implemented during the COVID-19 pandemic? These literature review study results are expected to be information and reference material in making online learning policies for teachers, students, schools, parents and the government [5].

2 Literature Review

2.1 The Benefits of Social Media in Education During the COVID-19 Pandemic

Social media allows users to easily participate, share and create content that includes blogs, social networks, forums and virtual worlds [6]. In the world of education, social media also plays an essential role in improving students' quality. Social media triggers students to take advantage of all the conveniences of communicating and sharing information that the media has for the educational or learning process and accelerating general information [7].

The COVID-19 pandemic suddenly requires an educational element to sustain online learning. This condition is very urgent to make innovations and adaptations related to the use of available technology to support the learning process. In practice, it requires both educators and participants to interact and transfer knowledge online. Online learning by utilizing social media platforms such as Whatsapp makes it easier for to students interact and discuss online and create a learning discussion forum and not spend too much money on its use [8]. Furthermore, the Zoom Cloud Meeting application, which provides remote conference services by combining video conferences, online meetings, chat, and mobile collaboration, allows teacher and student learning activities to interact more communicatively [9].

2.2 The Role of Social Media in Informing Students

Social media is a means of socializing online with other users. They can easily participate, communicate, interact and share information quickly and stay updated [10]. The sophistication and speed of social media also affect the continuity of education to bring about changes in administration, promotion, socialization, and so on [11]. Educational institutions have currently started using information and communication technology as a basis for more sophisticated learning. Most schools now use the internet, and complete facilities also support the learning activities and improve understanding [12].

They always keep up with the times and provide innovation, and are completed with a diversity of student input from elementary to high school [13]. Implementing social media can be done formally, which departs from the school policy and is neatly organized, directed and culturally carried out by the teachers even though there is no school policy regarding this matter. Moreover, national survey results found that 80.4% of junior high school students were internet users [14].

3 Research Method

This study conducted a study on how the Indonesian Government utilized social media as an alternative service in fulfilling education services in the Covid-19 Pandemic era. This study uses a qualitative approach with descriptive application to convey the results and values of social media content in order to improve educational services during the COVID-19 pandemic. This study also uses Q-DAS (Qualitative Data Analysis Software) to analyze social media data and Nvivo 12Plus to analyze social media content and data. The data was obtained from the Twitter account of the Indonesian Ministry of Education and Culture (KEMENDIKBUD), and the content limits taken at the start of the January 2019 pandemic, until now March 2021. Steps taken to retrieve hashtags from Twitter are shown in Fig. 1.

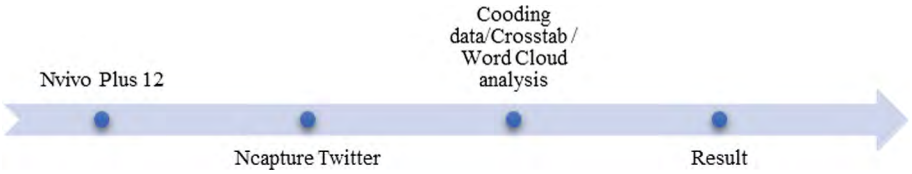


Fig. 1. Steps to retrieve data and analysis

4 Results and Discussion

4.1 Online Learning as a Solution During the COVID-19

Social distancing is an effort to maintain distance, such as avoiding crowds and physical contact. It is influential for the education sector. Studying at schools has been closed starting March 2020. Following the Health Quarantine Law, Article 59, Paragraph 3 of 2020, "this large-scale social restriction covers at least school and work vacations. Restrictions on religious activities and or restrictions on activities in public places or facilities. "In online learning, facilities and infrastructure are done through laptops, computers, smartphones, and internet network assistance. Besides facilities and infrastructure, a teacher must adapt to students' situations. In 2018, 62.41% of Indonesia's population owned cellular phones, and 20.05% of households had computers (BPS 2019). The data is relevant to the research results, showing that when students do not have a computer, they will use smartphones for learning (Fig. 2).

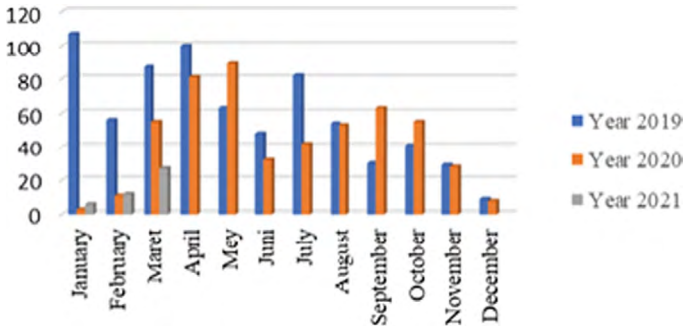


Fig. 2. Social media activities of the ministry of education and culture (Kemendikbud). Source: Coding analysis NVivo 12 plus Twitter account software

@kemendikbud's Twitter account has 38.1 thousand followers, follows 125 users, and has tweeted 8,522 posts. The 2019–2021 tweets above show the Ministry of Education and Culture's performance has been using social media during the COVID-19 pandemic. By digitization, @kemendikbud distributes free learning home portals to students as a learning innovation that suits student needs and accessible for free. Ministry of Education and Culture's information activities are getting higher in months, and the trend is increasing every year. The Ministry of Education and Culture's strategies include implementing educational services during the COVID-19 pandemic, making professional medical conferences seen from the increase Twitter account activity, content, social media service submissions, and knowing the word's frequency the picture, and signifying their activities (Fig. 3).



Fig. 3. Word frequency ministry of education and culture (Kemendikbud). **Source:** NVivo 12 plus Word Frequency coding

Based on the results of the Word Frequency, #Studyfromhome is the trending hashtag on @kemendikbud. The education indicator shows a high frequency of implementing services during the COVID-19 pandemic, where the three highest points show a learning

pattern in 2020 using internet-based multi-platform media. This journal is strengthened by research. Learning through distance learning (online) provides meaningful experiences for high school students without being burdened with demands to complete all achievement curricula for promotion and graduation (Fattah and Serono 2020). The innovation made by the Ministry of Education and Culture supports the Learning from Home through educational TV, advertisements broadcast on several radio stations, and affordable internet data provided by telecommunication providers (Fig. 4).

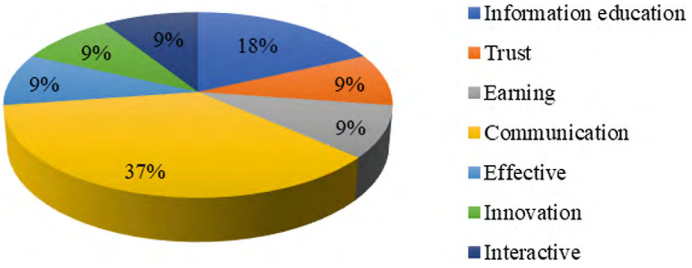


Fig. 4. Preview results of education learning during the covid period 19. Source: Crosstab Query-Rate (%) NVivo 12 plus

With actual and latest references based on attribute values through NVivo 12 plus, educational information is described in the table above. The Ministry of Education and Culture's (Kemendikbud) services during the COVID-19 pandemic has a slightly different proportion of content seen from the seven indicators above. Narrative communication between the community and the Ministry of Education and Culture is in the highest ranking (36.00%), signified by a survey followed by students and the public. There is still good communication between the community and the Ministry of Education and Culture. On the other hand, education information ranks second-largest, namely total (18.00%) compared to education information communication, which is lower because the public is still not updated about education information. The other five indicators start from the mandate indicator. Productive, effective, innovative, and interactive have the same results, namely only (9.00%) where the resulting product is minimal compared to scholarly communication and information (Fig. 5).

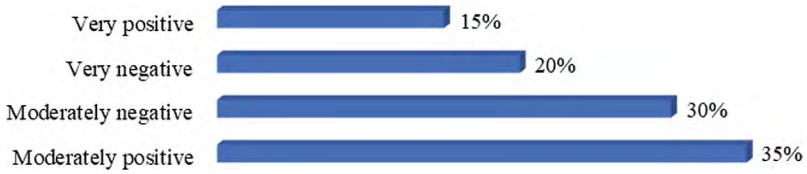


Fig. 5. Sentiment on the results of education learning during the Covid period 19. Source: Analysis Crosstab Query-Rate result sentiment

Findings based results analysis Crosstab Query-Rate Sentiment Above Moderately Positive shows higher results than the other three. Will indicates that the community

agrees with the Ministry of Education and culture's educational services. Community support is more dominant than people who do not support the Ministry of Education and Culture (Kemendikbud). However, online teaching and learning activities have not been convenient. Due to the lack of facilities and infrastructure for students to learn online during the COVID-19 pandemic, some do not understand current technology. Although delivery tools are not a determinant of student quality, subject design determines student learning effectiveness. One of the reasons for choosing a learning strategy is to promote meaningful learning. Whether the learning is effective or not can be defined through behaviour between learners and their responses. The learning process based on e-learning high school students needs supporting facilities and infrastructure so that learning can take place and have better quality.

5 Conclusion

Regarding education services during the COVID-19 pandemic, the Ministry of Education and Culture (Kemendikbud) will continue to implement e-learning. It is still impossible for face-to-face learning and helps prevent the virus spread. The lack of student facilities and infrastructures such as smartphones, computers, applications, and internet networks is the media for e-learning based education. On the other hand, the level of enthusiasm for student learning also triggers whether online learning is effective. The results showed that online learning was not as effective as conventional (face-to-face) learning because several materials had to be explained directly and more completely. Online learning is only effective for assigning assignments. The success of online learning during COVID-19 depends on all parties' discipline by making schemes to compile good management in regulating the online learning system. Creating a systematic, structured, and simple schedule to facilitate communication between parents and schools or madrasahs can help monitor the students effectively.

Acknowledgements. This research work has been supported by the Universitas Muhammadiyah Master's study program of governmental science. The authors would like to thank reviewers from the international conference on human interaction & emerging technologies.

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The Effects of Sound Interference on Soldiers Cognitive Performance, Workload Assessment and Emotional Responses

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Abstract. Twenty-three male soldiers were exposed to continuous (7 kHz sine wave), non-continuous (irregular 7 kHz sine wave) and no-sound conditions during performance of cognitive tasks on a tablet computer. Tasks were sustained attention to response (SART) task and Baddeley's 3 min reasoning task. Task performance, workload assessment (NASA-TLX) and emotional responses (pleasantness and arousal) were assessed after each sound-task condition. We expected that disturbing and task irrelevant background sound would interference concentration and cognitive function and therefore have detrimental effect on performance, workload assessment and emotional responses. We found no effects on cognitive performance. However, in connection with subjective assessments, (1) workload was significantly higher during non-continuous sound conditions as compared to continuous and no-sound conditions and (2) no-sound conditions were experienced more pleasant and less arousing than the sound conditions. The results are of interest when considering working in noisy environments, as well as cognitive resilience to interference.

Keywords: Cognition · Distraction · Workload · Emotional responses

1 Introduction

At the end of 2016, U.S. Embassy workers in Havana, reported suffering from symptoms such as hearing loss, nausea and dizziness, which were thought to have come from the use of some sonic weapon or sound interference against the embassy. The investigations did not found evidence of sonic weapon and concluded that the symptoms might have been associated with the locusts chirping (typically at 7 kHz) or alternatively fumigation to stop the spread of the Zika virus prominent around that time [1, 2]. Whether the symptoms were caused by fumigation, grasshoppers, or a sonic weapon, it is of importance to study the potential effects of sound interference on human performance to be able to mitigate potential harmful consequences. In addition to intentional interference, humans working environments have become more and more noisy thus potentially distracting

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 974–980, 2022.
https://doi.org/10.1007/978-3-030-85540-6_124

concentration and performance. In the present study, we were interested in examining whether disturbing sounds affects soldiers cognitive performance.

Environmental noise has been found to disturb sleep [3] as well as increase stress and cardiovascular risk [4]. People can in some degree get used to noise. This is especially true for noise that is predictable and consistent. There is also some evidence that background sounds may impair cognitive performance even though the evidence is not uniform. For example, Smith [5] found that performance on semantic processing test was impaired by intermittent, unpredictable noise, but that the noise had no effect on the syntactic reasoning test. The study suggests that unpredictable noise is more harmful for cognitive processing than consistent noise.

Sonic weapon use sound to injure, incapacitate, or kill an opponent. They are often based on loudness of the sound as extremely high-power sound waves can disrupt or destroy the eardrums of a target and cause severe pain or disorientation [6]. However, extreme sound levels are easy to detect and hard to produce and therefore their use in the battlefield or in hybrid-warfare is often impractical and uneconomical. In order to interfere with adversaries without revealing oneself, one could use lower sound levels that resemble natural or environmental sounds such as traffic noise or sounds coming from technological devices such as computers.

In the present study we wanted to examine whether disturbing and task irrelevant background sound would interference attention and concentration and therefore have detrimental effect not only on cognitive performance (in terms of sustained attention to response and grammatical reasoning), but also on subjective responses (in terms of workload and emotion). We used consistent and non-consistent 7 kHz sound that resembled a "coil whine" sound coming from a computer. Coil whine refers to a sound that is related to undesirable noise emitted by an electronic component vibrating as power runs through an electrical cable. We expected that sounds would impair performance, increase workload assessment and negative emotional responses.

2 Method

2.1 Subjects and Materials

Twenty-three male soldiers aged 23–32 (M = 24.6) participated in the study. Their task was to carry out sustained attention to response tasks (SART; see [7]) and Baddeley' 3-min reasoning tasks (see [8]) on a tablet computer. They were told that they should perform as well as possible and that during the test they may or may not hear background sound. Sound condition consisted of 7 kHz continuous or non-continuous sine wave sound or no-sound at all. The sine wave sound was produced with an online tool (https://www.szynalski.com/tone-generator/) and recorded to a computer. The non-continuous version of sound was generated with professional sound editing software simply by randomly cutting 1–5 s pieces of the continuous sound.

Concerning the tests, SART is a test that requires participant's constant attention and measures the speed and accuracy of his/her responses to a GO and NoGO stimuli. In the test subjects were asked to press response button as quickly as possible whenever other than number 3 was presented in the screen (i.e. one of the numbers 1, 2, 4, 5, 6, 7, 8, 9; GO stimulus) and refrain from pressing the button in the existence of number 3 (NoGO

stimulus). One round of the test took about 5 min and contained 225 stimuli, of which the proportion of NoGO stimuli was 25. The mean response time (GO stimulus) and number of errors in GO and NoGO stimuli was used to evaluate the level of performance.

The Baddeley 3-min reasoning tests consisted of 64 statements about the order of letters A and B that were presented in the screen either in order AB or BA (e.g., "B follows A", "B is not following A", "B precedes A" etc.). The participant's task was to answer correctly as many questions as possible in the fixed 3-min period. The number of corrects answers was used as a measure of performance.

Subjective responses were assessed with the NASA Task Load Index (NASA-TLX; [9]) and verbal statements corresponding to the 2-dimensional pleasantness and arousal model of emotion (see e.g., [10]). NASA-TLX consisted of multiple-choice questions about the mental, physical, and temporal demands of the task as well as the overall performance, effort and frustration level. Each dimension was rated on a scale of 1 (very low) to 20 (very high). The sum of the ratings was used as a workload measure.

Emotional responses were assessed with multiple-choice questions about the pleasantness (e.g., extremely unhappy and disappointed vs. extremely happy and satisfied) and arousal (e.g., extremely calm and sleepy vs. extremely energetic and aroused). Both dimensions were rated on a scale of 1 (very untrue for me) to 20 (very true for me).

2.2 Procedure and Data-Analysis

After a brief introduction of the experiment, the participants were seated in a lecture hall separately and with a 2 m distance of each other. After filling consent form, they were given the tablets and headphones and instructed about the course of the experiment. The experiment run automatically first through 3 task conditions in different and counterbalanced order for each participant for the SART task (i.e., SART with no-sound, with continuous sound and with non-continuous sound) and then through 3 task conditions in different and counterbalanced order for each participant for the Baddeley 3-min reasoning task (i.e., with no-sound, with continuous sound and with non-continuous sound). After each task, participants filled in the NASA-TLX and emotion questionnaire (also presented in the tablet). After finishing all tasks, participants were told to stay still and quietly until all participants had finished their tasks. The experiment took about 40 min in total.

The stimuli were presented in the center of the screen of Panasonic FZ-G1L2114T3 tablet using Inquisit stimuli presentation software (millisecond.com). Audio was adjusted to moderate level of 5 (about 60 dB - 70 dB SPL) in the tablet for all participants and presented through Logitech H390 USB headphones.

Given the quite low number of participants, the analyses was performed using Friedman's nonparametric analysis of variance in SPSS statistical software package with SART reaction time, SART error rate, Baddeley score, NASA-TLX score and emotional pleasantness and arousal ratings for each sound condition, each in turn, as test parameters.

3 Results

We found no statistically significant differences between the sound conditions for the cognitive performance test parameters (SART reaction times, SART error rates or Baddeley scores). In other words, soldiers were not distracted by the sound and were able to maintain steady performance level in all conditions.

However, the same was not true for the subjective assessments. The analysis revealed a significant main effect for the sound condition in predicting SART workload (NASA-TLX) score, $F\ (2,\ 23) = 8,\ 44,\ p = .015$. As illustrated in the Fig. 1. SART test elicited higher workload score during non-continuous sound ($M = 61{,}04$) as compared to continuous ($M = 57{,}87$) or no-sound ($M = 57{,}43$) conditions.

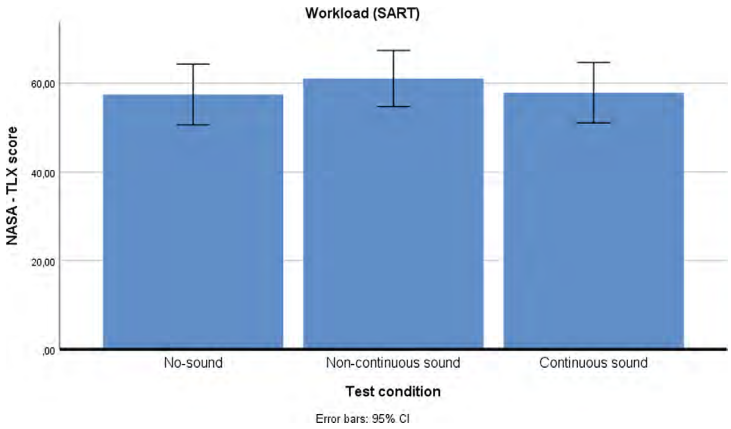


Fig. 1. Workload assessment score for SART test during no-sound, non-continuous sound and continuous sound test condition.

Analysis revealed also a significant main effect for sound condition in predicting pleasantness ratings for SART test, $F\,(2, 23) = 10{,}02$, $p = .007$. As illustrated in the Fig. 2, no-sound condition elicited higher pleasantness ratings ($M = 11{,}7$) than non-continuous ($M = 10{,}09$) and continuous sound conditions ($M = 10{,}09$).

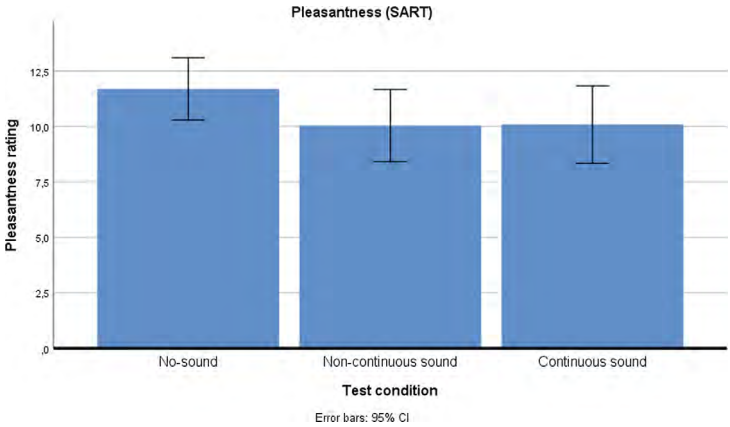


Fig. 2. Pleasantness ratings for SART test during no-sound, non-continuous sound and continuous sound test condition.

In connection with emotional arousal, as illustrated in Fig. 3, sound conditions (non-continuous and continuous sound) elicited higher arousal ratings (M = 10,89) than no-sound condition (M = 9,83) for Baddeley reasoning test, F(1, 23) = 178,00, p = .029.

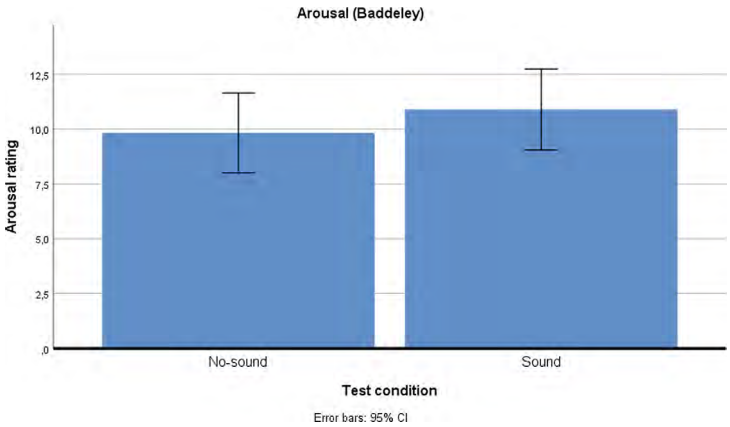


Fig. 3. Arousal ratings for Baddeley reasoning test during no-sound and sound test conditions.

4 Discussion

In the present study, we examined the effects of sound interference on soldier cognitive performance, workload assessment and emotional responses. We expected that disturbing and task irrelevant background sounds would reserve some attentional and information processing resources out of the resources allocated to primary task and

therefore increase workload and impede task performance. We also expected that soldiers would prefer no-sound condition to sound conditions to be able to perform better in cognitive tasks.

Our expectations were only partially supported. As expected, sound conditions as compared to no-sound condition elicited higher workload assessment and less pleasantness in soldiers during cognitive tasks. However, soldiers were nevertheless able to perform equally well in cognitive tests during disturbing sound as during without the sound. There are several plausible explanations. First of all, soldier are well trained to operate and perform under stress conditions and given also that the tests were quite short, it is likely that their performance got only marginally affected. Given also that the sound stimuli was irrelevant and in different modality than the actual cognitive tasks, they may have been able to mobilize and focus their attentional resources well to the task and block out the distracting information. The effects might have been different if meaningful sounds, such as speech would have been used as a distractor. In further studies, it would be interesting to compare different sources and types of sounds as well as expose the soldier to longer periods of sound distraction.

In modern society and warfare, people are exposed to intentional and unintentional attempts to influencing not only to their opinions and emotions but also on work performance, such as attention and decision making. It is important to study the mechanisms of influencing and interfering to be able to counteract and mitigate the harmful effects.

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Healthcare and Medical Applications

The Influence of Atmospheric Particulate on the Second Wave of CoViD-19 Pandemic in Emilia-Romagna (Italy): Some Empirical Findings

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Abstract. While the role played by air pollution and meteorological conditions on SARS-Cov-2 transmission is still subject of a scientific controversy, we have extended our analysis on this association by studying the impact of particulate on the beginning of the second wave in Emilia-Romagna (Italy), in the period October-November 2020. Again, we found many clues in favour of this hypothesis, with new results that shed a particular light on the time varying effect of the particulate on the virus spread. Specifically, we found a strong magnitude of correlation between the PM10 particulate and CoViD-19 infections, peaking at 6–7th day lags for contagions, while this magnitude drops to a medium level value with 9–11th day lags. This is of special interest, if we consider that the specialized literature suggests a median CoViD-19 incubation period of almost 6 days before that infected people display symptoms.

Keywords: CoVid-19 · Atmospheric particulate · Pearson's correlation · Second wave · Emilia Romagna (Italy)

1 Introduction

The link between the spread of the coronavirus disease 2019 (CoViD-19) and air pollution represents a questioned issue that has raised divergent views in the scientific community [1]. Many have argued that co-factors, such as quality of air and particulate matter in particular, may have played a role, yielding a number of negative CoViD-19 outcomes, including infections, deaths, and even excessive mortality rates. The motivations which are the basis of this hypothesis are that: i) fine particulate may work as a viral vector in the transmission of the virus and ii) it may facilitate the infection of the respiratory system, by disrupting the pulmonary defense system.

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 983–988, 2022.
https://doi.org/10.1007/978-3-030-85540-6_125

This hypothesis has also provided a plausible explanation to the reason why the virus has spread so unbalanced across different geographical areas in the world, even within the same countries.

Being the Po Valley, in Northern Italy, one of the most polluted areas in Europe, and also a hotspot for the first wave of the contagion, it has been the subject of several studies with the aim to understand the role of environmental pollution in influencing the spread of the virus during the pandemic. Some of those studies have corroborated this hypothesis, finding that a rise in the atmospheric level of the particulate was concomitant with the increase in the viral infection counts [2]. Among these studies, one has already shown the existence of a correlation between daily lagged values of particulates (precisely, PM2.5 and PM10) and adverse CoViD-19 outcomes, in all the provinces of the region of Emilia-Romagna in Northern Italy, during the first wave [3].

Italy's response to CoViD-19, that had allowed to contain the pandemic during that first wave, unfortunately broke down with the advent of the summer vacations and exposed the country to a second wave which surpassed the first one in intensity, starting in October 2020 and peaking around mid of November 2020 [4]. This dramatic situation, however, has offered the opportunity to investigate, again, on the hypothesis of the environmental pollution as a driver for viral transmission, also during the second wave.

In this context, this study has investigated the association between the CoViD-19 daily infection cases registered in the period 1 October - 12 November 2020 and the daily average lagged values of the PM10 pollutant, in all the nine provinces of the Emilia-Romagna region, in Italy.

The reminder of the paper is structured as follows. The next Section present the methodology adopted in our study, along with the main results we have achieved. Finally, Sect. 3 concludes the paper with some considerations.

2 Methodology and Results

The association, subject of this study, has been tested by exploiting the statistical hypothesis testing method based on the Pearson's correlation coefficient.

In particular, we computed the value of the Pearson's coefficient r by comparing two data time series. The first one is given by the infection counts registered on a given day X during the second wave of the pandemic (with X belonging to the temporal interval: 1 October - 12 November 2020), while the second one is the amount of pollution measured on day X - n, where the lag n was chosen from two different intervals: $\mathbf{A} = [8, 7, 6, 5, 4]$ and $\mathbf{B} = [12, 11, 10, 9]$, based on the literature which suggests a median CoViD-19 incubation period of almost 6 days before that infected people display symptoms [5].

To summarize the main results of this study: they have confirmed a strong magnitude of correlation between the PM10 particulate and CoViD-19 infections, peaking at 6–7th day lags for contagions, with Pearson's r coefficient ranging from approx. 0.6 to approx. 0.8, and a p value always less than 0.001, for eight out of the nine provinces in the investigated regions (except for Piacenza).

Instead, this magnitude drops to a medium level value with 9–11th day lags, where the Pearson's r coefficients range from approx. 0.3 to approx. 0.5; not only, but in many of those cases the p value display an unstable behavior.

These empirical findings seem to be of particular relevance as they are corroborated by similar results on the time varying effect of the particulate found by other authors during the first wave in a different European region [6].

Before we show these results in details, it is worth reminding that a very common empirical classification for interpreting the strength of a correlation by using the Pearson's r coefficient suggests that values less than 0.20 represent a very weak correlation, 0.20 to 0.39 represent a weak correlation, 0.40 to 0.59 a medium correlation, 0.60 to 0.79 a strong correlation, while 0.80 or greater is a very strong correlation. Despite the attention with which those values should be managed, it is commonly accepted that higher absolute values for r and smaller associated p values have the meaning of a robust distance from a null hypothesis of no correlation [7].

The following two Tables 1 and 2 display, respectively: the Pearson's r coefficient for all the days in the A temporal interval and the associated p values.

For a better visual comprehension of the magnitude of the association, in Table 1 we have put in evidence all the r values above 0.6 (strong or very strong) using a dark grey background of the cells, while for all values of r from 0.40 to 0.59 (medium) we used a light grey. The same as above was done in Table 2 for all the p values below 0.0001.

Table 1. Correlation between CoViD-19 spread and PM10 - Pearson's *r* coefficient. Day lags 8–4.

Province	Day 8th	Day 7th	Day 6th	Day 5th	Day4th
Bologna	0.61002	0.65945	0.62994	0.57674	0.56594
Ferrara	0.58364	0.61271	0.55860	0.50462	0.51837
Forlì-Cesena	0.66084	0.70124	0.70816	0.67757	0.67337
Modena	0.57602	0.62150	0.61529	0.56182	0.56236
Parma	0.59699	0.65012	0.67515	0.62365	0.62365
Piacenza	0.42790	0.49571	0.52424	0.49621	0.61705
Ravenna	0.69767	0.74090	0.72859	0.66957	0.64159
Reggio E.	0.56007	0.60908	0.61789	0.57798	0.57647
Rimini	0.76540	0.78566	0.79719	0.76405	0.75318

Table 2. *p-value*. Day lags: 8–4.

Province	Day 8th	Day 7th	Day 6th	Day 5th	Day 4th
Bologna	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Ferrara	<0.0001	<0.0001	<0.0001	0.0006	0.0004
Forlì-Cesena	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Modena	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Parma	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Piacenza	0.0042	0.0007	0.0003	0.0007	<0.0007
Ravenna	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Reggio E.	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Rimini	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

The following two Tables 3 and 4 show, instead: the Pearson's *r* coefficient for all the days in the **B** temporal interval and the associated *p values*. In Table 3, we used the same colors as above (dark grey, light grey) to highlight strong/very strong and medium levels of correlation, respectively, while the light grey In Table 4 emphasize *p values* below 0.0001.

Table 3. Correlation between CoViD-19 spread and PM10 - Pearson's *r* coefficient. Day lags: 12–9

Province	Day 12th	Day 11th	Day 10th	Day 9th
Bologna	0.35535	0.43657	0.47860	0.52103
Ferrara	0.48144	0.53633	0.54891	0.55864
Forlì-Cesena	0.36961	0.51331	0.57531	0.60970
Modena	0.41553	0.49650	0,50167	0.50186
Parma	0.37126	0.43649	0.46308	0.50205
Piacenza	0.27939	0.31956	0.33102	0.34839
Ravenna	0.50601	0.59245	0.64274	0.65928
Reggio E.	0.34744	0.42799	0.45161	0.48109
Rimini	0.53434	0.66206	0.71231	0.73043

Table 4. *p-value*. Day lags: 12–9.

Province	Day 12th	Day 11th	Day 10th	Day 9th
Bologna	0.0194	0.0034	0.0012	0.0003
Ferrara	0.0011	0.0002	0.0001	<0.0001
Forlì-Cesena	0.0147	0.0004	<0.0001	<0.0001
Modena	00056	0.0007	0.0006	0.0006
Parma	0.0142	0.0034	0.0018	0.0006
Piacenza	0.0696	0.0367	0.0301	0.0221
Ravenna	0.0005	<0.0001	<0.0001	<0.0001
Reggio Emilia	0.0024	0,0042	0.0024	0.0011
Rimini	0.0002	<0.0001	<0.0001	<0.0001

3 Conclusions

The link between the spread of CoViD-19 and air pollution represents a questioned issue that has raised divergent views. Nonetheless, we have found many clues in favour of this hypothesis both in a previous data analysis of the so-called first wave in the Italian region of Emilia Romagna and also with this new study focused on the beginning of the second wave in the same Italian region, in the period October-November 2020.

These latest findings shed a light on the time varying effect of the particulate. In particular, we found a strong magnitude of correlation between the PM10 particulate and CoViD-19 infections, peaking at 6–7th day lags for contagions, while this magnitude drops to a medium level value with 9–11th day lags.

Further to these latest results, our efforts to study the complex dynamics behind the spread of this virus are still continuing with the hope that they can inform policy-makers [8–11].

To conclude, it is the turn of the data: at the time of our study, they were all available on Italian governmental sites [12, 13]. All our experiments are reproducible using those data.

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Preliminary Comparison of Assessment Methods for the Trunk Flexion-Extension Movement in the Lumbar Vertebrae Instability Patient

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Abstract. The paper compares three assessment methods for the measurement of the trunk range of motion (ROM) in flexion-extension movements of subjects suspected of lumbar vertebrae instability (LVI). For five male adults affected by low-back pain and with morpho-dynamic prescription for suspected LVI, ROM was computed: from the analysis of morpho-dynamic radiographs, according to the definition proposed by i) Kapandji and ii) Yang et al.; from the analysis of the flexion-extension movement captured with an optoelectronic acquisition system iii) as the maximum angular stroke in transductors' displacement, according to a specifically designed custom protocol. Data obtained from optoelectronic acquisitions result comparable with literature values, suggesting the suitability of optoelectronic systems as non-invasive measurement tool for the trunk ROM assessing, to support the physician in the LVI diagnosis.

Keywords: Trunk flexion-extension · Lumbar vertebrae instability · Range of motion · Measurement comparison · Movement analysis · Morpho-dynamic radiographs · Optoelectronic systems

1 Introduction

Currently, investigations through radiographic images represent the gold standard procedure for the assessment of the spine functionality with diagnostic purposes, especially for pathologies affecting the ligamental stability of vertebrae such as spondylolisthesis or lumbar vertebrae instability (LVI) [1, 2]. In particular, morpho-dynamic tests allow measuring the trunk range of motion (ROM) in flexion-extension movements, providing images of the subject's spine in orthostatic position and in the conditions of maximum

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 989–994, 2022.
https://doi.org/10.1007/978-3-030-85540-6_126

flexion and extension. These measurement methods provide the physician with quantitative outcomes, and allow making diagnosis, but present drawbacks, such as: i) can induce significant side effects on the subject, ii) fails detecting pathological alterations generated by condition of loads on the lumbar spine, and iii) capturing only static information at specific trunk poses, cannot assess the evolution of the spine kinematics along the movement.

To avoid the latter limitation, more accurate measurement tests can be performed, e.g. fluoroscopy, but those techniques can even increase the potential side effects on the subject. Non-invasive measurement strategies like optoelectronic acquisition systems seem therefore appealing alternatives, since could provide advantages to both patients and society if adopted as first level screening tests, for instance reducing the risk of side effects on the subject and assuring health cost savings respectively. Moreover, these systems could be ideally used also under different working conditions for the subject. Nevertheless, these methods provide an indirect measurement of the spine kinematics [3] and present technical limitations affecting the accuracy of the ROM assessment, mainly related to transductors size and positioning [4–6].

Within this context, this paper aims at assessing the suitability of optoelectronic acquisition systems for the measurement of the ROM trunk in flexion-extension movements, for subjects suspected of LVI. The evaluation is performed comparing three assessment methods: from the analysis of morpho-dynamic radiographs, ROM was computed according to the definition proposed by i) Kapandji [7] and ii) Yang et al. [8]; from the analysis of the flexion-extension movement captured with an optoelectronic acquisition system, ROM was evaluated iii) as the maximum angular stroke in transductors' displacement, according to a specifically designed custom protocol.

2 Materials and Methods

The trunk's ROM was evaluated in a sample of five male adults (age 41 ± 15 years; height 1,77 ± 0,03 m; weight 75,2 ± 8,29 kg) affected by low-back pain and with morpho-dynamic prescription for suspected LVI, according to a protocol approved by the ethical committee of IRCCS Fondazione Don Carlo Gnocchi. Exclusion criteria were: i) inflammatory, systemic, rheumatic, neurologic or dermatologic diseases; ii) acute trauma in the musculoskeletal system; iii) spine or lower limbs surgery; iv) cognitive impairments affecting the indications' comprehension. All procedures were conducted according to the Declaration of Helsinki, and all the subjects provided a written informed consent to participate to the study.

The experimental setup included a radiographic system with remote controlled tilting table (CLISIS ACCESS, MECALL, Italy), and an optoelectronic acquisition system with 7 cameras and 20 skin passive optical markers (SMART-DX, BTS-Bioengineering, Italy). Markers were located on the landmark points corresponding to: i) central and transverse spinous processes of the lumbar spine (L1 to L5), ii) central spinous process of S2, iii) iliac spines. Spherical markers with a diameter of 15 mm were used for S2 and iliac spines, whereas hemispherical markers with a diameter of 6 mm were adopted for the lumbar spine.

For each subject, latero-lateral spine radiographs in orthostatic, maximum flexion and maximum extension position were acquired by an expert radiologist, and a trunk flexion-extension movement was captured with the optoelectronic system by trained operators. For optoelectronic acquisitions, the triplet of markers referring to each lumbar vertebra was exploited to create local mobile frames. In particular, the direction of X-axis is defined by the markers at transverse spinous processes (positive sense from left to right), and Z-axis is determined as the direction connecting the marker at the central spinous process with the mean point between the markers at transverse spinous processes (positive sense from central marker to mean point). Direction and sense of Y-axis is consequently obtained according to the right-handed coordinates convention for cartesian frames.

The angle α of maximum displacement was evaluated at maximum flexion (α_F) and extension (α_E), with respect to the orthostatic position, according to three strategies:

- *Kapandji*. S2's superior plate in orthostatic position identifies the baseline; α is the angle between superior plate of L1 in the specific condition and superior plate of L1 in orthostatic position.
- *Yang*. The angle between the superior plate of L1 and the inferior plate of L5 identifies both baseline (in orthostatic position) and α.
- *Custom*. The angle between longitudinal axes (Y-axes) of the mobile frames joined to L1 and L5 identifies both baseline (in orthostatic position) and α.

ROM was evaluated as the sum of the α_F and α_E in *Kapandji* method, and their absolute difference in *Yang* and *Custom*. Figure 1 depicts an illustrative example of evaluation of α_E, with both *Kapandji* and *Yang* methods. The rotation of the radiograph in Fig. 1 b) follows the actual measurement procedure, according to which images are aligned with respect to the baseline identified in orthostatic position (i.e. the superior plate of S2), to compensate for the relative movement of S2.

3 Results

Table 1 collects, for each subject, the measured values of α_F and α_E and the computed ROM, evaluated according to the three methods. For the whole population, mean values and standard deviation of each parameter are also presented.

Table 1. Values of maximum flexion and extension angles (α_F and α_E) and ROM, according to the three measurement methods, for each subject, and mean value and standard deviation (SD) of the analyzed population.

		Kapandji [deg]			Yang [deg]			Custom [deg]		
		α_F	α_E	*ROM*	α_F	α_E	*ROM*	α_F	α_E	*ROM*
Subject	001	80	18	98	28	54	26	30	-	30
	002	48	16	64	26	30	4	21	30	9

(*continued*)

Table 1. (*continued*)

		Kapandji [deg]			Yang [deg]			Custom [deg]		
		α_F	α_E	*ROM*	α_F	α_E	*ROM*	α_F	α_E	*ROM*
	003	72	22	94	26	60	34	23	55	32
	004	50	12	62	30	46	16	8	43	35
	005	70	20	90	24	44	20	20	35	15
Mean value		64	17,6	81,6	26,8	46,8	20	20,4	40,75	24,2
SD		14,21	3,85	17,23	2,28	11,37	11,22	7,96	10,90	11,48

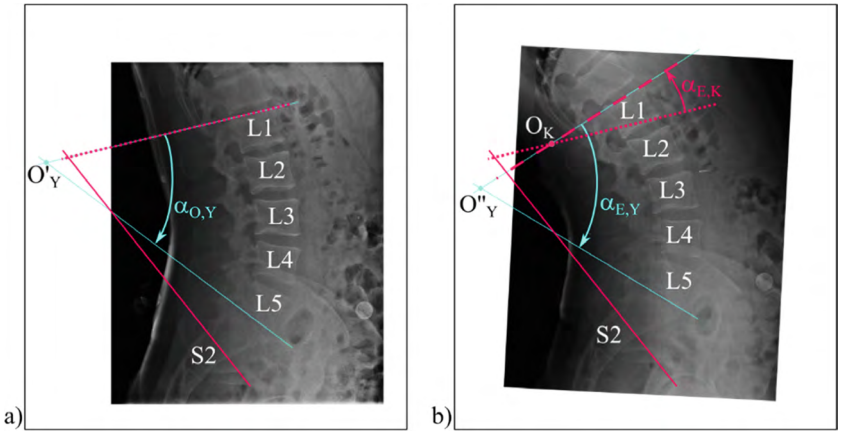


Fig. 1. Qualitative evaluation of α_E according to *Kapandji* (in red) and *Yang* (in blue) methods, using the radiographs a) in orthostatic position and b) in maximum extension condition. Continuous lines are used for the reference baselines, and O indicates the intersection of the directions of interest. Subscripts K and Y refer to the methods *Kapandji* and *Yang*, respectively.

4 Discussion

To compare the values of both α and ROM, as obtained applying the three proposed measurement methods, the parameters definition in the different cases should be properly evaluated.

The *Kapandji* approach could be considered an attempt to detect an absolute ROM, from a global perspective, since the definition of α aims at capturing the mobility of the lumbar spine as a whole, with respect to S2, i.e. a vertebra which can be approximated to quasi-static with respect to the subject's pelvis. Besides, the movement of S2 is compensated with the measurement procedure, allowing the evaluation of the lumbar spine ROM only. To enable this kind of global evaluation, the measurement procedure requires the simultaneous analysis of more instants of movement; in fact, α can be obtained only evaluating at the same time two distinct movement frames (orthostatic position and maximum flexion/extension condition). Moreover, from a methodological

perspective, the need for aligning independent images (see Fig. 1) represents a bias, since introduces a potential error source in the measurement procedure.

On the contrary, the *Yang* method could be considered a local assessment of the ROM, since its evaluation only involves the vertebrae of the lumbar spine. Likewise, the measurement of α is dependent on an instantaneous spine condition only, so that images alignments are not required.

For these reasons, although both the methods represent well established procedures in the medical practice, they provide ROM values not comparable each other. Nevertheless, the computed values (see Table 1) are consistent with literature data for both the measurement strategies, since ROM normality ranges are $80 \pm 15°$ and $32.5 \pm 13°$, for *Kapandji* and *Yang* method respectively [7–9].

The *Custom* approach grounds on the use of optoelectronic acquisitions. The designed protocol aims at detecting from the analysis of skin markers information about the underlying rigid bodies; for this reason, three markers have been used to capture the pose of each lumbar vertebra. The definitions of ROM and α in the *Custom* approach strongly resemble the ones of the *Yang* method, but the use of the Y-axis of local mobile frames instead of vertebrae superior plates introduces a remarkable advantage, easing the repeatability of the measurement process. In fact, although performed by experienced operators, the identification of the vertebrae plates is expected to be realized by manual procedure, whereas the evaluation of the frame axes from markers position can be performed through automatic computation. Besides, the inter- and intra-operator errors in markers positioning can be neglected as not significant with respect to the magnitude of the parameters involved in the movement. Referring to Table 1, the results of ROM and α obtained with the *Custom* method are consistent with the values computed with the *Yang* approach, also comparing the mean and standard deviation values as indicators of the population performance.

Nonetheless, optoelectronic acquisitions offer an indirect measurement, and data are affected by not-negligible errors. Among them, the most significant factors for the evaluation of the spine ROM are represented by: i) marker visibility, and ii) soft-tissue artifact. Although a proper experimental setup (e.g. optimized positioning of cameras) can strongly reduce the issue of hidden markers, the analyzed task is particularly sensitive to this phenomenon, especially for the extension movement: in our analysis this was for instance the case of subject 001. If marker visibility is a task- and instrument-dependent bias, the soft-tissue artifact represents on the contrary a subject-dependent error, affected for instance by the muscular condition of the subject in the investigated area.

Since the current results suggest the potential suitability of optoelectronic systems for ROM measurements alternative to the *Yang* method, a further experimental campaign has been designed and is currently ongoing. This study will enlarge the data sample with the primary purpose of better investigating the contribute of potentially critical factors such as subjects' sex, age and BMI.

5 Conclusions

This preliminary analysis suggests the suitability of optoelectronic systems as non-invasive measurement tool for the trunk ROM assessing, to support the physician in the LVI diagnosis. Further investigations are currently ongoing, e.g. enlarging the data sample to female subjects.

Acknowledgments. The authors warmly thank Raffaella Spinoni and Lisa Zatti for the precious support in the data collection.

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Influence of Technology and Quality Management on Nurses Working on Hemodialysis

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Abstract. The purpose of this article was to identify the influence of technology and quality management on the work of nurses working in hemodialysis. The methodology used was field research with a qualitative approach, through the study of multiple cases. Seven nurses participated in the research. The survey was conducted in March of this year. The subject's speech was used for analysis. It was concluded with this research that both technology and quality management positively influence the work of nurses working in hemodialysis. The technology reduces the handwritten workload, optimizing the time to be devoted to patient care. The quality management influence is positive because the standardization of procedures, facilitate the work process of the nurse indicating assertive decisions, search for continuous improvement, reliability and stability in relation to the techniques developed, equipment and resources used by nurses in assistance.

Keywords: Nurse · Hemodialysis · Technology · Quality management

1 Introduction

Currently, the importance of technology and quality management is observed in various environments, in industry, commerce, health, among others [1]. Technology can be defined as applied knowledge. In the case of the health area, it is understood as applied knowledge that allows the prevention, diagnosis and treatment of diseases, and the rehabilitation of their consequences [2]. With regard to quality management, in particular Total Quality Management - TQM, it is often cited as a strategic option to achieve competitive advantage. In the case of the object of the present work, it can also be considered as an important element for the improvement of the processes, whose advantages are discussed below. One of the most used tools for implementing a quality management system in an organization is offered by the series of ISO 9000 standards issued by the International Organization for Standardization [1].

A milestone in the history of quality in the health area was the creation of the Joint Hospital Accreditation Commission, in 1951, with the task of evaluating the quality of health organizations through Hospital Accreditation [3].

The contributions of technology in the health area are related to the development of biosensors and intelligent products, which facilitate communication between the real

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 995–1001, 2022.
https://doi.org/10.1007/978-3-030-85540-6_127

and virtual worlds. Big data strategies have become responsible for individualization and personalized health care. The connection between the machines becomes an increasingly growing reality, allowing an exchange of commands that generate more accurate results and in an increasingly shorter time [4].

Regarding hemodialysis services, many technological innovations related to equipment have been developed and new treatment modalities and strategies have been introduced [5].

Continuous monitoring through new technologies developed in our new equipment identifies the profile of hemodialysis, making it a potentially useful tool to provide quality assurance in each session, with the intention of reducing the incidence of adverse events and to ensure safety for the patient undergoing the procedure and also for the team of health professionals working on hemodialysis [6].

In the different work environments in health organizations, the work of professionals working in hemodialysis stands out. Nurses who work on hemodialysis have specific knowledge to monitor the procedure, which is called high complexity [7].

It is the nurse's responsibility to manage the care that involves actions directly linked to the patient, as well as the management of the nursing team, material resources and the entire systematization of care. In order to work in hemodialysis, the nurse needs to have specific qualifications in the area, which is essential for the good practice of care, in which the skills and abilities must converge to achieve comprehensive care for the patient who performs the procedure [8].

Through what has been described about technology, quality management and nurses' work, the guiding question of this study arises: how do technology and quality management influence the work of nurses working in hemodialysis?

The purpose of this article was to identify the influence of technology and quality management on the work of nurses working in hemodialysis. The methodology used was exploratory field research, with a qualitative approach, through the study of multiple cases. This research is justified because there is a constant technological evolution and implementation of quality management processes in the area of health and in the work of nurses.

2 Theoretical Framing

The term technology has a Greek origin, meaning discourse on the arts. It appeared in the 17th century, being identified as the applied arts [9]. In the 19th century, technology was a specialized term that shared a common set of meanings. These meanings related to a field of study with the practical arts, which were especially associated with engineers and modern industry. At the beginning of the 20th century, technology reached an increasing chain of means, processes and ideas, as well as tools and machines [10]. In the 21st century, there is an expansion of technology in the most varied areas of knowledge, placing the world in front of the Fourth Industrial Revolution, characterized by: artificial intelligence, internet of things, energy storage, biotechnology, autonomous vehicles and the most varied innovations [11].

Relating technology to health, there were significant benefits for the restructuring of systems in this segment [12]. Technologies in the health sector have contributed significantly to people's lives while simultaneously generating wealth and general economic growth [13].

Regarding quality management, it is a philosophy to continuously improve the quality of products, services and processes. The idea is that the quality of products, services and processes is the responsibility of everyone involved in their development and use [14].

Specifying quality in the health area, this issue becomes broader due to the specificities of each area and the service segment. The actors involved in this area are constantly looking for an excellent service that does not cause any harm to those looking for assistance and or care for their health [15].

In Brazil, in 1999, the National Accreditation Organization - ONA was created, a non-governmental and non-profit entity, which has the function of coordinating the accreditation system in the country [16]. The accreditation process is systemic and assesses the entire functioning of the health organization. The advantage of introducing management based on accreditation is related to improved management, the execution of techniques aimed at quality and customer satisfaction, as well as greater ability to obtain competitive advantage [17].

With regard to the pathology Chronic Renal Insufficiency and the treatment of hemodialysis, many transformations have occurred over time, and these transformations, which are perceived as positive, can be attributed to the advancement of technology and management processes of quality.

Chronic Kidney Disease - CKD represents a worldwide public health issue. In Brazil, currently, there are about 750 units of chronic dialysis, according to the 2016 census of the Brazilian Society of Nephrology [18]. One of the treatments indicated for Chronic Kidney Disease is hemodialysis. Its operation is performed through a machine with safety sensors, dialyzer filters, arterial equipment, venous equipment, and dialysis solutions that replace the patient's kidney function [19].

For the operationalization of hemodialysis, a specialized multidisciplinary team is required. The nurse is a professional who is part of this team. In particular, nurses who work on hemodialysis must excel in assistance that perceives the patient in a holistic way [20]. It requires constant observation of the signs and symptoms presented and referred by the patient during the procedure, the monitoring of the functioning of the hemodialysis machine and the materials used and the competence to analyze and make assertive decisions to resolve events, thus benefiting the patient's safety [21].

The nurse's work is complex and dynamic. The assistance provided, whether in care or management, becomes challenging. Health organizations have prioritized aspects of care, customer satisfaction, operational efficiency, culminating in the success of effective quality management [22, 23].

3 Research Method

The methodology used was exploratory field research, with a qualitative approach, through the study of multiple cases. Indicated as inclusion criteria that the participants

were nurses who worked in hemodialysis units that were accredited, that is, they had a quality management seal.

Four accredited hemodialysis clinics (HDA1 to HDA4) were selected for the multiple case study in three Brazilian cities, of which seven nurses were interviewed as described in Table 1.

Table 1. Sample distribution

City	Clinics	Nurses
Passos - city of Minas Gerais	HDA1	Enf.1 e Enf.4
São Paulo - city of the state of São Paulo	HDA2 e HDA3	Enf.2, Enf.3, Enf.5, Enf. 6
Sorocaba - city of the state of São Paulo	HDA4	Enf.7

Subtitle: (HDA) Accredited Hemodialysis; (Enf.) Nurses.
Source: Authors, 2021.

Nurses were asked through the WhatsApp® application how technology and quality management influenced their work. It is worth mentioning that the conversation application was used, due to the emergency phase that the country is experiencing, with restrictions of social distance due to the Coronavirus pandemic.

The field research was carried out in March of this year. In addition to the field research, a theoretical reference research was carried out through published articles, using the databases of Latin American Health Sciences Literature - LILACS, International Literature in Health Sciences, MEDLINE, and Electronic Scientific Library - SciELO. The eligibility criteria for the articles were: correspond to the descriptors "Technology", "Quality Management" and "Hemodialysis", "Nurse's Work", be a scientific article and be available in full. Books were also used that addressed the topic in a current and meaningful way.

The analysis of the results was performed through the reading of the answers to the questioning, analysis of the subject's speech, which is a flexible text reading methodology whose object of study is speech [24], after the synthesis of comments from research subjects.

3.1 Results and Discussion

Through the results obtained when questioning how technology and quality management influence the work of nurses working in hemodialysis, in terms of technology, nurses say that the influence is perceived and experienced in several ways: from the ease of communication with the team of work, access to internal protocols and standards, use of state-of-the-art hemodialysis machines that provide safety to patient care, thus improving their quality and life expectancy. In addition to these issues, technology also assists the multidisciplinary team in organizing all data and prescriptions for patients, creating graphs that monitor the goals established for the assistance provided.

In modern times, the use of technology has provided remarkable opportunities to reduce the incidence of adverse events that may occur in patients on hemodialysis.

Technology is a tool to support nurses, increasing efficiency and even the quality of care and patient safety [25, 26].

It is important to describe that with each new technology that appears in the assistance routines provided by nurses, it also increases the complexity of their work, but at the same time it can reduce the burden of this work, improving the quality of care [27].

Regarding the influence of quality management on the nurses' work process, it is indicated that it facilitates the work process through continuous improvement management. The philosophy of quality requires nurses to have a conscious leadership, committed to the service and motivated in order to infect their team [28].

The nurse must encourage the participation of all his team in the decisions, facilitate and participate in the process that involves patient care, show the importance that each one has within the work team, distribute the tasks according to the responsibilities and dividing the merit of the achievements [29].

It has also been described that quality management assists in the management of inputs used for the hemodialysis procedure, avoiding waste. The management of material resources has been a matter of concern in health organizations, both in the public and private sectors, it is necessary to control consumption and costs to prevent employees and patients from being deprived of the necessary materials [30].

The role of nurses in the administration of material resources is an achievement in the spheres of decision-making, highlighting the importance of their role in the technical-administrative dimension inherent to the process of caring and managing [30].

Other factors indicated by nurses is that quality management encourages the practice of improvement through the continuing education of the nursing team. It is important to highlight the concern of nurses to invest in their own development and that of their work team, propagating the importance of improving and professional development according to their potential, expectations and needs [31]. It assists in the monitoring of goals and objectives to be achieved as a way of offering nursing care based on maximum effectiveness, efficiency, and efficacy in the treatment of hemodialysis. It makes assertive decisions possible in the work process developed by the nurse. It is observed that the principles of quality management are used to plan, identify and control processes, promote environmental organization, train human resources, perform critical analysis, meet customer requirements and promote continuous improvement [32].

4 Conclusion

It is an important part of the nurse's responsibility to plan, organize, coordinate, execute and evaluate the services where nursing care is recommended, so they are also the spheres where technology and quality management are inserted. It is important that nurses understand and use these mechanisms to benefit the work performed.

Through the research carried out it was possible to perceive that both technology and quality management positively influence the work of nurses working in hemodialysis. The technology reduces the handwritten workload, optimizing the time to be dedicated to patient care. It is worth mentioning that the technology used in hemodialysis machines and equipment for the procedure provides nurses and patients with greater safety, creating

perspectives for improving the quality of life and patient safety. Regarding quality management, the influence is positive because the standardization of procedures facilitates the nurse's work process, indicating assertive decisions, seeking continuous improvement, reliability and stability in relation to the techniques developed, equipment and resources used nurses in providing care.

Acknowledgments. This study was partly financed by the Coordination for the Improvement of Higher Education Personnel - Brazil (CAPES) - Financial Code 001.

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Machine Learning Algorithm Selection for a Clinical Decision Support System Based on a Multicriteria Method

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Abstract. On the current information in the medical area related to cancer analysis, the selection of an optimal Machine Learning algorithm, based on a multicriteria method, for a system that supports clinical decisions is sought. As a methodology, exploratory research and the deductive method were applied to analyze the information from existing articles and ML algorithms' behavior applied in the area of medicine. This research and based on a use case of training and testing of the GLM, SVM, and ANN algorithms for selecting an algorithm. Addition-ally, for clinical decisions, and architecture prototype for medical data collection is presented resulted. Based on AHP and TOPSIS methods Support Vector Machine (SVM) is the best alternative.

Keywords: Decision clinical · Machine Learning · Multicriteria method · Support aystem · Medical data

1 Introduction

Machine Learning (ML) has applications in various areas such as medicine, computing, financial analysis, customer services, and processes; here Information and Communication Technologies drive the computing, storage, security, and memory environment [1]. According to the review of related works, ML has many applications in the medical area, as it applies different algorithms or combines them to obtain diagnostic information and prediction of results. ML is a subset of Artificial Intelligence (AI), it has several statistical algorithms and methods, it is related to traditional statistical models [2]; with techniques to carry out complex tasks, it has components of mathematics, statistics, and computer science, it is used in industry and academia through data sources; set of mathematical procedures to describe the relationships between variables [3].

About the algorithms, in ML the following are identified: Logistic regression (LR), k-nearest neighbor (KNN), support vector machine (SVM), random forest (RF), Naïve Bayes (NB) [1], and natural language processing (NLP). Generalized Linear Model, Decision Tree (DT), Gradient-Boosted Trees (GBT) [2], artificial neural networks ANN,

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 1002–1010, 2022.
https://doi.org/10.1007/978-3-030-85540-6_128

extreme boots (EB) [4]. Much ML research is currently aimed at diagnosing and predicting diseases such as asthma, breast cancer, stroke, diabetes, heart problems, hypertension, hemoglobin disorders, kidney problems, liver problems, lung cancers, Parkinson, problems to the prostate [1], affectations to the skin, ophthalmology, pathology, and radiology [2]. A concern in ML is accurate prediction; in the case of image recognition, if the input data is pixels in image, video, or geographic location, this data is complex and non-linear; it is difficult to describe the relationships between predictors and results [3].

The problem is the selection of a suitable ML algorithm for a system that supports clinical decisions.

Why is it necessary to select an ML algorithm for a clinical decision support system based on a multicriteria method?

To know the algorithms in ML and adopt one that helps in the early detection of cancer through medical imaging, and with this information, make better decisions; Furthermore, as the proposal of a model that uses ML is necessary, the cancer factors must be determined, and the variables to use ML in the medical domain must be identified.

The reason for using a supervised algorithm in research is because these use a data set that contains many variables and the main result [3].

The objective is to select an ML algorithm for a clinical decision support system based on a multicriteria method.

As a methodology, exploratory research and the deductive method were applied to analyze the information from existing articles and the behavior of ML algorithms used in medicine.

2 Materials and Methods

2.1 Materials

An exhaustive review of the algorithms used in 48 references was carried out, here it turned out that the most used is SVM, then RF, and DT; the main diseases identified are heart, diabetes, breast cancer, and Parkinson's [1]. Authors trained supervised algorithms such as SVM, ANN, and LR; SVM is the best prediction model [3]. The authors analyzed a data set here the algorithms applied were RF, DT, LR, NN, EB, and SVM [4]. The purpose of these algorithms is to understand the reasons that patients re-enter with the same symptoms once they are discharged [5]. The authors tried to prevent the increase in diseases due to climate change or environmental contamination and that people suffer complications [6]. We also found implementations of a new method that uses the soles of the feet to identify the sex of the person; the most effective was NB with high precision to decipher sex [7]. Authors used various learning algorithms, such as cross-validation, to manage depression detection in 5749 animal registries [8]. Certain authors improved the prediction of response to treatment in 67 patients with cancer [9]. The authors applied an ML algorithm to have a greater precision of the evaluation in psychiatry; they use the LR algorithm and get improvement [10]. Other authors proposed to predict the survival rates of patients with tumors of the pancreatic duct; for this, they used the RF algorithm since it uses regression or classified methods to create decision trees at the time of

their learning [11]. To identify 192 patients suffering from tuberculous pleural effusion [12]. SVM and k-NN are used for a better decision guide in rehabilitating people at home with 1250 observations [13]. Other authors applied data mining techniques for predictive models in a breast cancer data set; they concluded that SVM predicts with less error and greater precision [14]. Likewise, other authors used SVM and GBT for prediction and probability in data from 118 patients with the paroxysmal disease and reduced the classification to 7 variables [15].

2.2 Methods

- The scope of the proposal is to choose and use supervised algorithms to propose an architecture for the collection and modeling of medical data; for this, several ML algorithms are trained and tested for cancer analysis and prediction; here the algorithms must analyze data from medical images; after modeling the data, they are tested with the algorithm and the results are presented; the results obtained are analyzed and interpreted; with this, we seek to select the appropriate algorithm for cancer analysis and support for medical decision making.
- TOPSIS and AHP methods were used to select the best algorithm.
- The statistical programming language R version 3.6.3 was used as an open-source for 64 bits; the R environment is accessed through the IDE RStudio version 1.2.5042 [3]. The platform is S.O. Windows 8 64 bits, 2.50GHz Intel Core i5 processor, 8GB of RAM, 250GB of hard disk was used. The data sets are from the Wisconsin Cancer [16], which has 497 sets for the ML community.
- Data Set is Liver Cancer; Characteristics of the data set: Multivariate; Number of instances, records or rows: 345; Zone: Life; Attribute Type: Categorical, Integer, Real; Number of attributes or characteristics: 7
- Algorithms for training and testing: The training was carried out with the following algorithms: Logistical Regression with generalized linear models (GLMs), Support Vector Machines (SVM), and Artificial Neural Networks (ANN) with a hidden layer

3 Results

3.1 Prototype Architecture for Medical Data Collection and Processing

An architecture is proposed, Fig. 1, general to assist in the collection of data belonging to patients and will be stored and processed by ML algorithms; it has five layers and we explain them below:

Device Layer: Patient data is collected, and medical devices that can be found in a hospital capture that data; these devices have an interface for data capture and must have another interface to send data over the network; doctors or health professionals use the devices to capture the data.

Network Layer: Here the different forms of communication are used to obtain the data through the infrastructure of a hospital; it can be a wired network, wireless network, BlueTooth, or RFID.

Cloud Layer: Here are several considerations, the first is the storage of the data generated in the device layer in any data format; the second are services that can be used

by any user or application of a hospital; the third is the management of the architecture and software applications that the hospital has; the fourth is the database that contains the normalized and standardized data that was generated by devices and applications; the fifth is security for device access to the network, profiles of healthcare professionals, and permissions to run applications.

ML Algorithms Layer: ML processes were separated for better segmentation of the proposed architecture; here are the standardized data of a type of cancer in a text file; this data must be generated by one of the services located in the Cloud Layer; the training and testing processes of the selected algorithms are executed on the standard data.

Decision-making layer: With the results of ML algorithms, the healthcare professional can give a more objective diagnosis based on the precision, sensitivity, specificity, and characteristic curve of each algorithm executed.

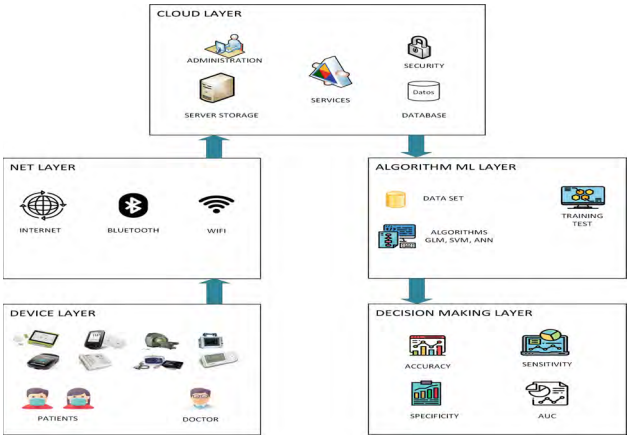


Fig. 1. Prototype architecture for medical data collection and processing.

3.2 Use Case: Training and Testing of GLM, SVM, and ANN Algorithms

Training Phase:

Figure 2 case of liver cancer, the deviation indicates that this one sample is between 0.008 and 0.009 units of distance as the highest value; another sample is between 0.004 and 0.005 distance units as the lowest value. By using GLM in data sets with many characteristics, the Logistical Regression model's performance increases that the load of the characteristics of the data is reduced through regularization; in this investigation, selection operators were used for the classification of characteristics.

Figure 3 case of liver cancer shows the different levels of log lambda, the best value is $x = -4$, it is in a vertical dashed line; it is noted that the randomness of cross-validation means that log lambda values can be changed between analyzes; the size of the log lambda also decreases, the number of variables increases, and the magnitude of each tumor characteristic increases.

For the SVM algorithm, the data is adjusted through a function used in the R code, this is similar to the regularized regression; as a set for training for the X-axis there are the 6 characteristics, for the Y-axis there are the controls. For the ANN algorithm, through the R code, the neural network is adjusted; for this, the X-axis and Y-axis data sets were defined in the training sessions with the number of hidden layers using a size argument.

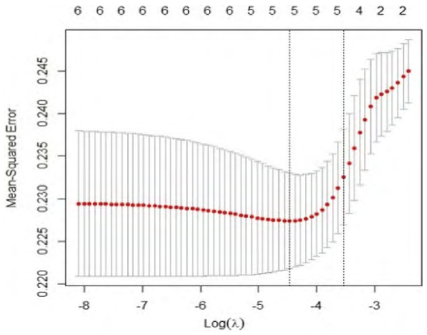


Fig. 2. Validation curves for the GLM model.

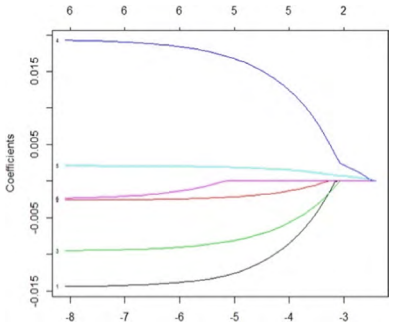


Fig. 3. Regression coefficients for the GLM model.

Confusion matrix: In the case of liver cancer, in GLM there are 5 benign negative and 66 malignant positive tumors; in SVM there are 24 benign negative and 61 malignant positive tumors; in ANN there are 48 benign negative and 67 malignant positive tumors. Regarding the average of the predictions of the three algorithms, there are 25 benign negative tumors and 61 malignant positive tumors.

Test Phase

Operating characteristic curves: The operating characteristic curves (ROC) are useful and are shown in Fig. 4 through the R code; these curves show the relationship between the sensitivity established on the Y-axis, the specificity established on the X-axis. Case of liver cancer, the SVM algorithm is the best performance with AUC = 0.9668; then this Regularized Regression with AUC = 0.5446, and the ANN with AUC = 0.5000 of performance. Inaccuracy the best scoring algorithm is 0.7391 from SVM.

3.3 Selection of an Algorithm for Clinical Decision

Figure 5 case of liver cancer otherwise shows the algorithm indices, only for this case SVM is better in precision and data classification; insensitivity it is in the average of the other algorithms; in specificity, it is in second place.

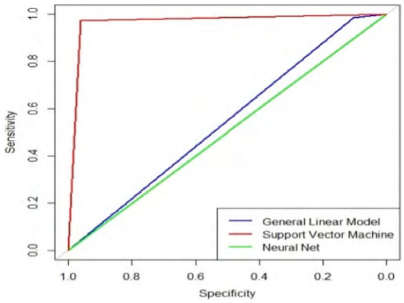


Fig. 4. ROC Curves.

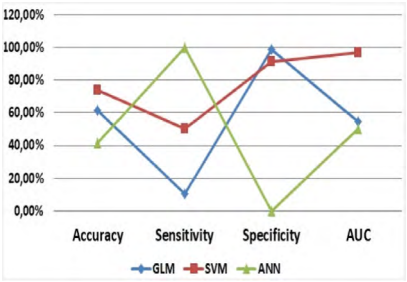


Fig. 5. Operation curves.

Due to the variety of causes and types of cancer and the Machine Learning models used, this seeks to solve the problem of making complex clinical decisions with multiple criteria, taking advantage of the TOPSIS Method, this consists of a technique for the order of preference by similarity with the ideal solution. The Analytical Hierarchy Process (AHP) is a structured technique for dealing with complex decisions. Rather than prescribing the "right" decision, this method helps decision-makers find the solution that best meets their needs and understanding of the problem. AHP is most useful when finding complex problem decisions with high stakes to select methods or technology that meet certain criteria.

Based on Table 1, on Analysis of Models in Machine Learning, the importance of the criteria was established.

Table 1. AHP method for selecting criteria importance

	Accuracy	Sensitivity	Specificity	AUC	
Accuracy	1.000	2.000	4.000	3.000	
Sensitivity	0.500	1.000	2.000	2.000	
Specificity	0.250	0.500	1.000	2.000	
AUC	0.333	0.500	0.500	1.000	
sum	2.083	4.000	7.500	8.000	
					Weights
Accuracy	0.480	0.500	0.533	0.375	0.472
Sensitivity	0.240	0.250	0.267	0.250	0.252
Specificity	0.120	0.125	0.133	0.250	0.157
AUC	0.160	0.125	0.067	0.125	0.119
checksum	0.840	0.875	0.933	0.875	1.000

The MCDM problem was revised using the TOPSIS Method for liver cancer, through the Normalized Matrix calculation, with the analysis of the calculation of the best and worst ideal value.

Table 2. Topsis method for MCDM in liver cancer

	Accuracy	**Sensitivity**	**Specificity**	**AUC**
weight	0.472083333	0.251666667	0.157083333	0.119166667
Normalized Matrix				
GLM	0.6174	0.1041	0.9850	0.5446
SVM	0.7381	0.5000	0.9104	0.9668
ANN	0.4174	1	0	0.5
Ideal best and ideal worst value				
GLM	0.588615062	0.09270887	0.734368825	0.447463264
SVM	0.703687686	0.44528756	0.678750638	0.794358215
ANN	0.397939629	0.89057512	0	0.410818274
Euclidean distance from the ideal best				
GLM	0.277875361	0.023331732	0.115357103	0.053322706
SVM	0.332199229	0.112064036	0.106620413	0.094661021
ANN	0.187860667	0.224128073	0	0.048955844
	Si+	**Si−**	**Pi**	**Rank**
GLM	0.21208278	0.146386392	0.408365349	**3**
SVM	0.11240408	0.205338544	0.646241726	**1**
ANN	0.19034139	0.200796341	0.513364794	**2**

Based on these results Support Vector Machine (SVM) is the best option.

4 Discussion

- The use cases presented are a guide to cancer data training and testing, and not all algorithms work for all types of cancer. While other types of cancer have other types of data, some other characteristics, the data sets may be unbalanced. ML is stated to be an optimal tool for medical diagnosis and procedure; however, it is not intended to replace physicians' decisions.
- According to the use cases applied to a specific cancer dataset, any of the three algorithms, SVM, GLM, and ANN provide an acceptable diagnosis to determine whether a tumor or cancer is benign or malignant.
- The architecture proposal does not consider hardware, device infrastructure, network, or cloud space prices; it is also not considered times of implementation of the architecture of programs, but the prototype's functionality. The code used must be updated

according to the characteristics of the data set; the data set must be formatted according to the conditions of the domain to be analyzed to be used in the chosen ML algorithm; the more patient data is generated into the architecture, the better the ML algorithms perform.

- The theoretical consequence of this research is the consideration of the architecture and the algorithm for collection, storage, and processing. The SVM algorithm resulted better in precision and data classification; insensitivity is defined between GLM and ANN, and in specificity are GLM and ANN.

5 Conclusions and Future Work

In this paper, a proposal on the architecture and algorithm to obtain, store and process cancer data is a confirmatory tool to support decision making is proposed in our case study the SVM algorithm resulted in the best option based on TOPSIS and AHP methods. With the selection of one of the ML algorithms, it was concluded that the architecture and algorithm prototypes presented serve to support the decision-making of health professionals. As future work, an analysis of Machine Learning algorithms for data processing in the cloud environment will be proposed.

Acknowledgments. This work has been supported by the GIIAR research group and the Universidad Politécnica Salesiana.

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Healthcare System Sustainability by Application of Advanced Technologies in Telemedicine and eHealth

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Abstract. Recent years have been characterized by global changes related to epidemic and emergency situations in a number of countries and regions. This requires rapid and adequate changes in the healthcare system. The development of modern technologies contributes to the timely response in supporting people's health in accordance with the imposed restrictive and remote ways of communication. This gives a reason to look at eHealth in a new promising way for modern healthcare. In this regard, the application of Information-Communication Technologies (ICT) and specialized computer software applications in Telemedicine for the needs of healthcare are of paramount importance. This report aims to present modern ways to help people and facilitate their work through the application of advanced technologies.

Keywords: Healthcare · Telemedicine · eHealth

1 Introduction

Modern healthcare is unthinkable without the use of advanced technical means [1]. These include Information-communication technologies (ICT), specialized computer systems, artificial intelligence and others [2]. This is logically justified given the dynamics of the XXI century related to the mass mobility of people within cities and different areas, as well as the growth of human population [3]. In this context, it is desirable to use advanced technologies in health practice, which leads to the optimization of healthcare through the introduction of positive telemedicine services [4]. Also, at state and academic level, it is necessary to prioritize the creation of units, centers and departments actively working in

Technical University of Varna (www.tu-varna.bg) is a full partner in CIII-HU-1506-01-2021 Ergonomics and Human Factors Regional Educational CEEPUS Network 9 European partners: HU (General Coordinator), AT, BG, HR, PL, RO, RS, SI, SK: https://sites.google.com/view/ceepusergohf/home.

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 1011–1017, 2022.
https://doi.org/10.1007/978-3-030-85540-6_129

the field of Ergonomics and Human Factors for the needs of the Sustainable Healthcare system. An example of this is the newly established collaboration for scientific and educational purposes CIII-HU-1506–01-2021 Ergonomics and Human Factors Regional Educational CEEPUS Network 9 European partners: HU (General Coordinator), AT, BG, HR, PL, RO, RS, SI, SK [5].

Given the diverse types of diseases, hospitals (public and private) are specialized or multidisciplinary. There is also an option for treatment in university hospitals, which are also divided into specialized and multi-profile ones. In Bulgaria, hospital treatment is regulated by the Health Act [6]. This law is regulated by the Medical Establishments Act [7]. According to it, the medical establishments are two groups: medical establishments for hospital care and medical establishments for ambulatory care.

This report examines the important aspects that make up the modern sustainable healthcare system (Fig. 1).

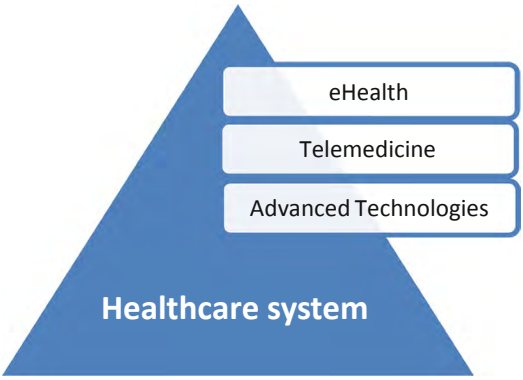


Fig. 1. Sustainable healthcare system.

Through the prism of advanced technology means in order to build a comprehensive sustainable Healthcare system there are examples of the application of telemedicine and eHealh given, significantly improving healthcare.

2 Vision for Sustainable Healthcare System by Applying Application of Advanced Technologies in Telemedicine and eHealth

A sustainable healthcare system depends on many factors [8]. They can be very different, with special priority being the healthy financial environment (national, regional, etc.), the attitude of the society, the infrastructure and others. Recent years have been characterized by the development of medical and health technologies [9]. This opens up new possibilities for their application and with the right approach and methodology this can lead to improved healthcare [10]. In this regard, telemedicine finds its place, especially when there is a period of epidemics and quarantines. These conditions require the rapid application of modern technical means and resources of ICT for adequate treatment

[11]. The Table 1 shows social commitment, application of advanced technical means and priorities for healthcare needs.

Table 1. Social commitment, eHealth and application of advanced technical means and priorities for the needs of healthcare system.

Application	Priority
Social care	- Care and responsibility of the society - Health prevention - Active way of living - Sports - Positive motivation - Ecology and healthy environment
Conventional medicine	- Science - Education - Practice - Experience exchange
Ergonomics and human factors	- Human-machine relationship and environment - Sustainability - Periodic optimization of ergonomic systems in accordance with rapidly changing conditions
Information-Communication Technologies (ICT) and telemedicine	- Safety - Implementation of new technologies for data exchange - Optimization of synergistic connections between: administration - doctor, doctor-doctor, doctor-patient
Digital currency for payment	- Innovative methods for electronic payment
Specialized software for monitoring and ensuring environmental friendliness	- Real-time work - Monitoring of environmental parameters - LCA tools and methods
Artificial intelligence (AI)	- Application of AI in modern healthcare - Use of assisted electronic help through AI - Control and monitoring of AI work

2.1 Social Care

Every developed country or regional union of the European Union type is committed to caring for the protection of human health. In principle, this is the responsibility of society, which through various methods of prevention, active lifestyle, development of children's and youth sports maintain a good level of health status. These include motivation, the development of strategic goals committed to the development of a sustainable healthcare system. Creating and protecting a healthy environment is also important [12].

2.2 Conventional Medicine

Conventional medicine is a strategically basic field of development, which acquires significance with active involvement in science, education and practice [13]. The active exchange of experience between medical professionals and students, the development of collaborative projects and programs stimulate and contribute to the inclusion of conventional medicine in building a sustainable healthcare system [14].

2.3 Ergonomics and Human Factors in Healthcare

The main activity of ergonomics is the study and coverage of specific conditions, influencing factors and different relationships in the human-machine-environment relationship [15]. Speaking of ergonomics, an analogy is often made with the search for sustainability. Ergonomics is applied in a number of areas related to work, living and social environment. One of the main goals of modern ergonomics is the periodic optimization of ergonomic systems in accordance with rapidly changing conditions. Sharing good practices is a priority for ergonomic professionals involved in the development of sustainable health. For example, the leading conferences AHFE (Applied Human Factors and Ergonomics), IHSI (Intelligent Human Systems Integration) and IHSED (International Conference on Human Systems Engineering and Design) are organized annually, where specialists from all over the world share publicly positive ergonomic experience.

2.4 Application of ICT in Telemedicine

ICT has a leading position in the already established modern telemedicine [16]. Using the resources and capabilities of ICT, information between doctor and patient is easily and conveniently translated. Of course, these can also be links between specialists, doctors and administration in order to speed up the transfer of information, and in certain cases in real time there is an opportunity to make timely decisions and measures to overcome health problems, accidents requiring rapid reaction of medical professionals and others [17]. Real practical examples, where telemedicine is with a purpose:

- Monitoring the vital signs of people with diabetes. For example, the company "Electron Progress" Ltd. in cooperation with the Military Medical Academy participate in a program collaboration [18].
- Providing remote medical care to a wide range of users where it is possible to:
  - Communication between doctor and patient for follow-up of chronic diseases;
  - Long-distance examination in case of influenza and other viral diseases. For example, on the territory of the Republic of Bulgaria such services and activities are developed by the Life Insurance Institute and “Lev Ins” company [19];
  - Dental care. "Mediva" - a 24-h medical and dental center offers a wide range of health services (including dental) through the specialized telemedicine eHealth platform MedCare [20].

2.5 Digital Currency for Payment

Along with the development of electronic means of communication and the possibilities for electronic banking, virtual currencies are gaining more and more popularity. The virtual currency bitcoin is rapidly gaining ground on the market worldwide [21]. In the field of healthcare, the concept of payment with virtual currency is actively promoted by the leading dental clinic "Dentaprime". The currency is called Dentacoin, and detailed information on what it is and how it is positioned is presented on the platform's page. The positive example is that this and other multinational companies working with a wide range of professionals and customers around the world need [22].

2.6 Specialized Software for Monitoring and Ensuring Environmental FriendlinessSpecialized Software for Monitoring and Ensuring Environmental Friendliness

Modern software such as CAD systems, where 3D models are solid, allows real-time environmental computation to be calculated. LCA tools and methods [23] are used, which provide information on the impact on carbon emissions, air and water pollution, and energy consumption. It is also possible to define transport and forecast of the product life cycles in years. Dasaault Systemes SoidWorks Premium is a software that fully provides these vital parameters for environmental protection and monitoring of the sustainable eco and social system [24]. The integration of this and other types of similar software is a very good tool for the prevention of important processes in the era of Industry 4. This directly affects the health of living organisms and significantly optimizes a number of important production and logistics activities.

2.7 Application of AI for Healthcare Needs

Artificial intelligence is a specific field of science that is increasingly used in the modern Healthcare system. Digitization and the development of electronic smart devices contribute further to the faster integration of AI in practice. To protect human health, we are working hard on systems such as:

- Tracking control. It is applied in places where there is a crowd of people: airports, train stations, stadiums, etc., for monitoring purposes [25].
- Autonomous vehicles of any type. For example, Tesla in the construction of autonomous cars [26], Rolls Royce in shipping [27].
- In the field of healthcare, a number of applications are being developed to support one or another type of activity related to the protection of human health. A clear example of a successful application of AI for healthcare is the award-winning online platform Symptoma (Austria). Through it, in open access, any interested user can enter the available symptoms and receive assisted help from the computer system and AI bot [28]. The platform is actively used by customers - doctors and patients. The platform is currently available in many languages and countries, including Bulgaria [29].

3 Conclusion

This report presents in a systematic way the application of advanced technologies in telemedicine and eHealth to ensure the sustainability of the healthcare system. The advantages and benefits of the integration of modern technologies are detailed, and specific examples from practice are given. The active sharing of experience leads to the mass application of the studied technologies. Researchers recommend optimizing working healthcare systems with the introduction of improved technologies. The information attached to the report shares experience with stakeholders, trainees, researchers and healthcare professionals.

Acknowledgments. The paper is supported by the Ergonomics and Human Factors Regional Educational CEEPUS Network - CIII-HU-1506–01-2021.

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Scaling the Magnetic Resonance Imaging Through Design Research

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Abstract. The superior soft-tissue contrast and sensitivity for pathologies have made magnetic resonance imaging (MRI) a primary modality in medical imaging. At present, the high initial and running costs, and demanding requirements for siting and operating personnel limit its availability to large hospitals and imaging clinics. Improved accessibility of MRI technology can lead into new healthcare services. To study this, we set up the Accessible Magnetic Resonance Imaging (AMRI) research platform, including a multidisciplinary research team and a very low field MRI device for evaluation of new service solutions. We explored the expected value of accessibility in point-of-care contexts, achieving validation and improved focus for initial need-descriptions for the solution. Our design research points towards the potential of a more accessible MRI in improving healthcare provision, and that ever-prevalent medical imaging healthcare services could cause systemic changes to the healthcare processes, technologies, and operating environments.

Keywords: Magnetic resonance imaging · Accessibility · Healthcare service design · Medical device design

1 Introduction

Accessible Magnetic Resonance Imaging (AMRI) is a research project between Aalto University's School of Electrical Engineering, and School of Arts, Design and Architecture. The project aims to bring Magnetic Resonance Imaging (MRI) out of the conventional hospital environment, enabling new transformational point-of-need services in healthcare and wellness. The technology solution in question potentially decreases local and global inequalities by bringing quality healthcare in the form of accessible medical imaging to areas and uses not addressed before, in line with the United Nations Sustainable Development Goals 3 and 10 [1]. The goal is reached by designing a research platform of a very low field MRI (VLF MRI) scanner. The collected information about the possibilities and limitations enables the development of MRI scanners and services for different applications. The medical community strives for more ubiquitous and accessible MRI systems, and lowering magnetic field strength can increase adaptability [2].

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 1018–1025, 2022.
https://doi.org/10.1007/978-3-030-85540-6_130

AMRI scanner upscales the accessibility of imaging in terms of e.g. safety, mobility, and user experience, making it a compelling solution to many domains. In parallel with the technology development track, a design research effort gathers information about selected potential application domains (e.g., healthcare and wellness), application areas (e.g., mobile and hospital), and use cases (e.g., pulmonary imaging and cerebrovascular emergency). The aim is to validate and prioritize these to inform the development of the technology.

The contributions of the article are in describing our research findings of the potential needs the technology in question addresses. This applies to different application domains and use cases, supporting a platform-approach in a technology-centric, multi-disciplinary research project. Within this study, six application areas were researched with designerly means. For brevity, this report focuses on two of those.

1.1 Scaling as a Design Process

We consider scaling from the value creation perspective: how could more accessible MRI -device and service bring value to different application areas? An approach focusing on combining products with the corresponding services is often called Product-Service Systems (PSS) [3]. Adoption of service design approach in healthcare and participatory and co-design methods has been emerging for almost the last two decades now. E.g. Experience-Based Co-Design (EBCD) has been formalized as one answer to this objective [4].

Since service is a process in which value is co-created between the involved stakeholders, identifying and exploring them in different application areas was considered important. Service design is a challenging co-creation process, as the people involved are uniquely influenced by their initial conditions and setting [5]. This raises the importance of human-centered perspective, including e.g. identifying their needs and experiences. This study considers the potential operators of AMRI (e.g. paramedic, radiographer, nurse) as users.

It is a major challenge to identify the most suitable environment for scaling up a healthcare innovation [6]. The initial use cases for AMRI resulted from the technology researchers' state of the art expertise in the field. From the potential application areas, six were selected for design exploration, from which two (emergency and healthcare) are in focus of this report.

Product architecture design is concerned with mapping the functional elements of a product to the structural ones [7]. During the recent decades, platforms and modular product architecture approaches have become mainstream, enabling mass-customized production. For the enterprise, this allows addressing and managing external complexities (e.g., market and society complexities) as well as internal complexities (e.g., product portfolio and manufacturing complexities) [8]. The planned platform-approach with wide applicability poses a challenge for acquiring information sufficiently to guide the technology research. Designerly research methods may prove valuable understanding for furthering in this quest.

1.2 AMRI-SCANNER Research Platform

MRI provides high soft-tissue contrast and is capable of generating anatomical images with high resolution and speed. The inherent limiting factor in exploiting these features is the signal-to-noise ratio, which is proportional to the magnet's strength. The continuous pursuit of high-resolution images within as short time as possible has led to strong superconductive magnets with field strengths of 1.5 and 3 T. Recently, 7 T scanners have been introduced.

Field strength determines costs (~$1M/T), safety measures, required facilities, and expertise in operating the system [2]. The high field magnet scanners are expensive and costs are not limited only to the price of the scanner. The requirements for the operating environment are also high and increase with the field strength. The operation of a high field MRI unit assumes highly educated personnel. The strong magnet and high excitatory radio frequency power also causes safety risks for the people. These issues make the running costs of a high field MRI the most expensive radiology service. Due to the costs and the required infrastructure MRI scanners are mainly used in hospitals.

The AMRI project aims to identify new MRI concepts of high value in some applications where accessibility in terms of safety, costs, availability, and mobility is of significant importance. There are also several essential applications, which would benefit from openness and a possibility to bring life-supporting or monitoring pieces of equipment close to the magnet. The scanner's safe operation enables automation of the imaging process, and the image-based diagnosis may be delivered via teleradiology.

The AMRI scanner platform is composed of a VLF MRI scanner and a computer simulation platform. The scanner is based on a permanent magnet producing a VLF range, below 0.1 T, for whole-body imaging. Technology enables a more compact device design and transformability. The scanner will be used for collecting empirical data for the development of computer simulation tools. This research environment is used for modelling and optimization of VLF MRI systems for the chosen applications. The operation at a VLF range enables fulfilling the above-listed requirements for accessibility. The downside is that the signal to noise ratio will be significantly lower than at high field operation. When this is considered, one may find several health and wellness applications where VLF MRI provides high value due to good tissue contrast and accessibility.

The aforementioned improvements in accessibility (initial and running cost, safety, usability, user experiences, and mobility) of the AMRI scanner platform are the basis of the high value provided for healthcare and wellness of the population.

2 Research Through Design

AMRI's maturity-level allowed us to arrange design research parallelly with the development of the technology. Dorst [9] addresses the details and impacts of co-evolution of design problem-space and solution-space and the different levels on which this occurs in a project -especially in processes where design is used as a means for knowledge-building, as opposed to mere problem-solving. Re-framing of the problem takes place when the effort is made towards solutions, resulting in increased knowledge of the problem. Research through design is about building knowledge through design [10]. According to Koskinen et al. [11] constructive design research is an activity where the

construction, typically of a prototype (product, system, scenario etc.) is a key element constructing the knowledge. In our study, design efforts towards developing a concept of emerging technology were placed into different application areas to build knowledge about its possibilities and limitations. As described above, knowledge-building via design requires field research and design-doing of representations. This also applies to service design; the significance and variety of benefits of design representations, including prototypes, are well documented [12].

Design exploration of the possible application areas considered Finnish municipal healthcare system providing 95% of all specialized medical care [13] during a Master's course in Aalto University, School of Arts, Design and Architecture in Autumn 2020. The participating 18 graduate design students were divided into six groups of three persons each, with a heterogeneous distribution of backgrounds with regards to gender, country of origin, and design discipline. Each group was assigned to work with one of the six possible application areas for six weeks. Medical imaging was a new domain for most of the participants. Progress was endorsed with supporting lectures and reading material on e.g. design emergence, user-centered design, design research methods, design for medical context and MRI technology. The Authors advised the groups from technical and design perspectives during the whole process. Groups had the freedom to re-frame the given initial problem-space based on revealed insights.

In the following, the design exploration related to point-of-care, and mobility domains is summarized, respectively.

2.1 Point-Of-Care Diagnostics

Insights of point-of-care diagnostics were gathered from a total of eight expert interviews (2 Radiologists, 2 doctors, Radiographer, ICU medic, ICU nurse, and medical engineer), and for one person prior experience on MRI scanning as a patient. ICU personnel were interviewed in situ, and other interviews were conducted via videoconferencing. The acquired data was transcribed and structured with affinity diagrams [13]. Key findings for the conceptualizing the use of AMRI in general diagnostics were:

1. Accessible MRI would enable the imaging in the first appointment with a nurse or doctor, and many times only the 'yes' or 'no' answer from the images would be enough for precluding conditions. However, currently only radiologists can consider the clinical significance of the findings, hindering the MRI use among other medical experts. Artificial Intelligence (AI) could aid in scanning decisions.
2. Technology provides significant time and effort saving potential in ICU. MRI scanner could be brought next to the patient bed, instead of taking the patient to the scanner. The 'yes' or 'no' answer from the images would be often enough in ICU for precluding conditions.
3. MRI would be used more if it would be more accessible. AMRI could and should provide a safer, more inclusive and pleasant experience for the users. However, excessive imaging could congest healthcare.
4. MRI process design should be comprehensive and include the individual needs of patients, and improve the pleasantness of the scanning environment. Operators are

key actors in reducing the negative experiences. Devices should be tailored according to different target groups and application domains.
5. MRI service is a profitable business for private healthcare, whereas in public healthcare scanning requires careful consideration due to costs.

Based on the background research findings, further design efforts focused in developing concepts for MRI utilization in more efficient primary health care examination. Another team re-framed their design research towards a new bed-side MRI experience in ICU context from these conclusions. The research through design was illustrated with stakeholder mapping [12], key stakeholder personas [12], a storyboard [12], and a product design concept [11], and a user experience (UX) journey map [14].

2.2 Mobile Application Areas

Two conceptual mobile AMRI approaches were researched, those of ambulance use, and mobile non-emergency diagnostics. Multiple user-research and co-design methods were used. Total of 9 expert interviews were conducted (3 Medical engineers, 2 Paramedic lecturers, Emergency Medical Technician officer, Sales director, Electrical design manager, and Area sales manager). Two of the interviews were conducted at the premises of an emergency vehicle manufacturer, and at a rescue center, respectively. A co-design workshop took place in paramedic teaching facilities.

The background study identified emergency cerebrovascular diagnosis (stroke) as a potential mobile use case for MRI. The main purpose of the conceptualized stroke unit is to differentiate strokes and brain hemorrhage of a patient. This time-sensitive diagnosis aims to select the right treatment from the mutually exclusive ones. In cerebrovascular issues, all means that expedite care have a crucial positive impact on patients' life, recovery, and quality of life post-event. The other key findings were:

1. The standard for ambulance design [15] makes it challenging to install AMRI into the already weight-burdened current ambulance platforms.
2. Paramedics perform multiple parallel tasks and are simultaneously co-operating with multiple units, hospitals, and call centers. The knowledge is distributed to the environment (system) and the people involved.
3. There is no standard ambulance: paramedics have considerable influence in designs of ambulances, and the manufacturer provides the role of technical implementation specialist.

The findings necessitated focusing on diagnostic units not to be used primarily for patient transportation. As a next knowledge-building effort, a co-design workshop [16] with paramedic students was set up. It was organized in a training ambulance, after having built a mock-up of AMRI device, and having generated a protocol addressing a cerebrovascular emergency event with the contact points paramedics are involved with. During the workshop, the paramedics acted out the protocol of moving the patient in and out from the scanner with the stretchers and maintaining contact with the patient in different scanning phases.

During the workshop, the participants fine-tuned the protocol, found detailed improvement needs, and strengthened our intuitions. Situated Post-it notes were used to indicate the issues in the device mock-up or elsewhere in the physical context, enabling effective documentation. The participants were motivated as they could see their insights having an effect on the actual protocol development. The mock-up and the environment served as essential framing elements for staging and piloting the process and the system mock-up, in alignment with [12]. For example, it became apparent that both paramedics operating the system need to have visibility to the system status, initially not possible in the mock-up.

3 Discussion

Design research in the project aimed to find out needs and analyze and describe certain related tasks, as well as the physical, social, and process-related environments of use. Results provided vital guidance in goals, requirements, constraints, and opportunities for the technology and the PSS development. The technology will potentially replace elements in the current healthcare service provision models, introduce new processes, and change the roles and even power dynamics, requiring systemic understanding and thoughtful planning.

3.1 Involvement of Different Stakeholders

Clinicians, as decision-makers and operators of the MRI, are vital as users and informants in the domain. They were the primary group of informants at this stage of our research. On the other hand, patients are equivalently important informants. E.g., uncomfortable patient experience in current MRI systems is a well-known issue, as the experience is considered claustrophobic, noisy and long-lasting by many. For a good reason, patients have been included lately more and more into the design process of healthcare services [4]. Patients will be involved more in the design process when our design process develops. In PSS development, insightful co-design workshops are encouraged [17] and these will take place in later phases, involving clinicians and patients. Two of the interviews were contextual inquiries: the medical doctors and nurses at the Töölö Hospital's ICU unit and Helsinki Rescue Department (both located in Finland) were interviewed in their natural work setting. The context enables the interviewees to point-out examples from their surroundings for additional information [18]. We found the clinicians very willing to discuss their work and the role of technology, including different imaging modalities in healthcare. In the discussions, they were also able to project towards the future. However, they were very much aware of the various constraints towards applying new technology.

The process of knowledge building through design exploration resulted in a corpus of analyzed research material. This included: context scenarios (8), personas (7), user journeys (5), and with product, service, and User Interface design concepts (10). Next, some issues for scaling the AMRI as a Product Service System are discussed.

3.2 Imaging Process

Accessible MRI could enable other practitioners to complement radiologists in solving simple clinical questions [2]. In the early phases of medical care, AMRI could streamline the current processes. Safe operability in a normal hospital room and lower investment cost would enable the acquisition of the scanner to department level. Compact size and mobility could allow shared use of scanners between departments. We found that ICU doctors were expected to have basic image reading skills. There, early interpretation could support radiology and improve efficacy, with proper technology and process.

As an example of further service system level potential, the broader use of scanning enables longitudinal monitoring of patients' recovery. Extensive use of scanning provides cumulative data and extends the human health archives. Accurate early diagnostics could decrease specialist care need.

Recently, the integration of complex machine learning algorithms and artificially intelligent systems within medical safety and image review has increased [19]. AI holds a promise to support clinical decisions for appropriate justifications of examinations and in improving throughput. AI assistants could complement humans and depend on us for tasks in which we have a comparative advantage. As Stanford University radiologist Curtis Langlotz put it: "AI won't replace radiologists, but radiologists who use AI will replace radiologists who don't." [20]. Siemens recently introduced an AI-based MRI scanner that enables automated routine scans [21]. This releases radiologists and radiographers from the routine work and broadens the pool of operators.

4 Conclusion

Technologies based on very low field MRI are under increasing interest in medical imaging [2], promising a significant downscaling of cost, risk, volume, training, and other accessibility-related metrics compared to conventional MRI. We reported a concerted effort and results involving design research in the need-finding phase of a research project. We evaluated application areas of point-of-care for the emerging technology called Accessible Magnetic Resonance Imaging (AMRI). Designerly knowledge building methods provided insights on goals, requirements, constraints, and opportunities for further development of the core technology and the Product-Service System (PSS). Accessible MRI technology would enable broader use of medical imaging in healthcare services. We discovered a potential in Intensive Care Units: the imaging process efficacy would improve if moving the patient for scanning is eliminated. Emergency cerebrovascular diagnosis proved a potential use case for VLF MRI on a mobile platform.

Further research is needed as the more accessible medical imaging suitable for healthcare services causes systemic changes to the processes, humans, technologies and operating environments. These impacts and opportunities pose an inspiring co-design challenge, when furthering our research on selected application areas.

Acknowledgments. We wish to thank the Technology Industries of Finland Centennial Foundation, and Jane and Aatos Erkko Foundation for their support of this research.

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Social Distancing Experiment Based on UWB Monitoring System

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Abstract. Keeping social distance is important to contain the spread of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and reduce the risk of getting infected. Some wireless communication technologies such as Ultra-wideband (UWB), Bluetooth, Wifi can help to accomplish that. This work focuses on UWB technology due to its impressive accuracy in location and tracking applications. More specifically, this paper shows the impact of an UWB-based social distancing monitoring system on people's behavior. The experiment consisted of detecting and registering the events of breaking the social distance policy established at 1.5 m for more than 20 s between 15 people during four days. The main result showed that even if the place has the proper signaling for social distancing, the adherence percentage of the social distancing policy was only 13%. On the other hand, with a real-time audible alert generated by a device of the monitoring system, the adherence percentage increased to 33%.

Keywords: Social distancing · UWB-communications · Infrastructure-less · Technology for healthcare

1 Introduction

The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) pandemic caught the world off guard. The number of deceased and infected people around the world increases every day. Today many fields of science are researching and developing solutions that allow people to return to daily tasks [1–6]. Many protective measures were published by the World Health Organization (WHO) [7], one of them is to keep social distance. Due to the easy spread of the virus and the asymptomatic cases, social distancing is one of the best non-pharmaceutical approaches to contain it. Many countries and organizations around the world have adopted social distancing policies to ensure people's health.

In this context, some technological solutions have been developed to help ensure social distancing. For example, in [8, 9] the authors proposed solutions based on computational vision and machine learning. Other related works made use of some wireless

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 1026–1033, 2022.
https://doi.org/10.1007/978-3-030-85540-6_131

technologies such as Bluetooth, GPS, Wi-Fi and UWB (cf. [10–12] for more discussion on this). As mentioned, there are many technological developments focused on maintaining social distance. In, [13, 14] the authors presented a complete overview of technologies and techniques used for indoor localization and social distancing where parameters such as accuracy, energy efficiency and latency are compared. This work focuses on UWB technology due to the high accuracy in the distance measurement that this experiment demands.

UWB technology is characterized by a high bandwidth ($\geq$500 MHz) [15]. The standard for UWB communications was published in the release (i) of the IEEE 802.15.4a where the UWB physical layer was added [16]. UWB communications have by far the largest allocation of bandwidth. For example, the US Federal communication Commission (FCC) allocates 7.5 GHz of band between 3.1 [GHz] and 10.6 [GHz] with a restriction power available to a transmitter, near to 0.5 [mW] [17]. In 2008 the European Computer Manufacturers Association (ECMA) specifies in its ECMA-368 a multiband-OFDM system that divides the frequency spectrum into 14 bands and 6 band groups. Each band has 528 [MHz] of bandwidth [18]. Other important features of UWB are:

- Have a noise-like signal spectrum.
- Are resistant to severe multipath and jamming.
- Have a good time-domain resolution allowing for positioning and proximity applications.

Unlike previous works, in this paper we analyze the behavior of a group of people using an UWB-based social distancing monitoring system. This social experiment presented herein suggests that despite the implementation of protection measures and the proper signaling to keep social distance, people tend to disrespect social distancing. The main contributions of this work are:

i. The deployment of an UWB-based social distancing monitoring system in an industrial scenario, taking real measurements of people's behavior.
ii. The implementation of a four-stage methodology in the experiment to quantify the real impact of the monitoring system. In each stage, the subjects receive a certain level of information starting with a zero-knowledge about the experiment and ending with a personal real-time warning when the social distancing policy is broken.
iii. The correct processing of the collected data to generate a log of contact between the subjects. This allows generating an early and fast people isolation protocol in case of infection based on real data.

The remainder of this paper is organized as follows. Section 2 shows the elements of the system and its function. Section 3 talks about the stages of the experiment and how it was carried out. Section 4 displays and discusses the results based on statistics generated during the experiment. Finally, Sect. 5 presents the conclusion about the experiment.

2 System Overview

The social distancing monitoring system is composed of two main devices: the tags and the gateway. The characteristics and functions of each one are described below.

2.1 Tags

A tag is an electronic device worn by users as an id badge, as shown in Fig. 1.



Fig. 1. Tag worn by a participant.

The device is an UWB radio based on a DW1001c chip. It has a 700 [mAh] battery that guarantees five operating hours. It runs an UWB multi-range protocol that allows distance measurement from 1 up to 16 simultaneously. Other features of this gadget are:

- Contains an adapted buzzer to emit an audible alert.
- Have a unique alphanumeric ID.
- Stores the ID, the time-lapse, and the date of the event. An event occurs when the distance between two or more devices is less than 1.5 [m].
- Downloads the stored data to the gateway via UWB.

The tag operation is described as follows: First, each tag continuously transmits a pulse. Between transmissions, the tag listens for UWB pulses emitted by other tags. When an incoming pulse is detected, the distance between the devices is calculated by a package exchange based on the two-way range protocol. Here it is worth mentioning that the multi-range protocol allows for the previously described process to take place with multiple devices at the same time. If the calculated distance is less than the allowed, two concurrent processes start in the device. The first one is an audible alert that the tag emits to warn the user about the proximity with another person. The second is the storing parameters. A tag gets the ID, the time-lapse, and the timestamp when an event occurs. Both processes finalize when the devices move apart into a “safe” distance. Finally, the download of the stored data is performed via UWB. When a tag passes near the gateway the tag automatically establishes a link and starts transmitting the data.

2.2 Gateway

The gateway is a fixed element that must be placed in a common area for the tags. This guarantees that all the data is obtained. This device is configured as a listener i.e. it does not emit any kind of pulse; it just collects the data from the tags. The gateway connects via UWB to the tags and via Ethernet to a local area network (LAN). The collected data is sent to a computer that is connected to the same LAN listening to incoming data. Figure 2 illustrates the gateways set up.

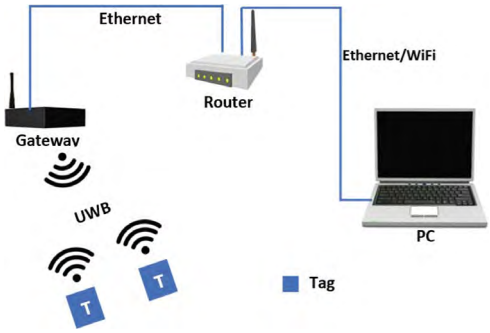


Fig. 2. Gateway connection diagram.

Once a tag and the gateway establish an UWB link the tag downloads the stored events and removes them to avoid data duplication in the gateway. Due to UWB, the gateway can get ten events per second from each tag. The received raw data is processed on the PC to generate useful data. With this useful data, if someone tests positive, an isolation protocol can be rapidly executed to avoid more cases.

3 The Experiment

The experiment was carried out during a 4-day period, one stage per day. The participants belong to one of departments of the company. The place was well signposted to warn about social distancing. Also, self-care tips were posted in common areas and the use of the mask was mandatory.

The experiment consisted of analyzing the behavior of 15 people by means of an UWB monitoring system with a specific tag configuration. The experiment measured the number of times the individuals broke the social distance policy which consisted of standing near another subject at a distance fewer than 1.2 m for more than 20 s. Each day, when the users register their entry in the morning, a tag was given to them. After they finish their working day, the tag was given back. Further details and the different tag configurations used on each day of the experiment are described below.

3.1 Day 1: No Feedback

On the first day the tags were configured in silence mode, i.e., the devices do not emit any kind of alert if an event occurs. The only instruction that was given to the users was

always to carry the tag with them. The data generated in the 15 tags was later collected by the gateway and processed to obtain the first results.

3.2 Day 2: It is an Experiment Due to SARS-CoV-2

On the second day, the tag was again configured in silence mode. Unlike day 1, it was explained to the subjects that the devices (tags) are part of an experiment that aims to measure their proximity with their coworkers due to the SARS-CoV-2 pandemic. At the end of the working day, the tags were returned, and all the collected data was processed.

3.3 Day 3: Look How You are Behaving

The data obtained from day 2 was presented to the subjects as visual feedback. It consisted of two pie charts that showed them the adherence percentage of the social distancing policy, see Fig. 3 (a), and the distribution of the events according to the time-lapse, see Fig. 3 (b). This was done to observe their responses (conduct during the day), having prior knowledge of their general behavior. The tags were also configured in silence mode and the data was collected in like manner.

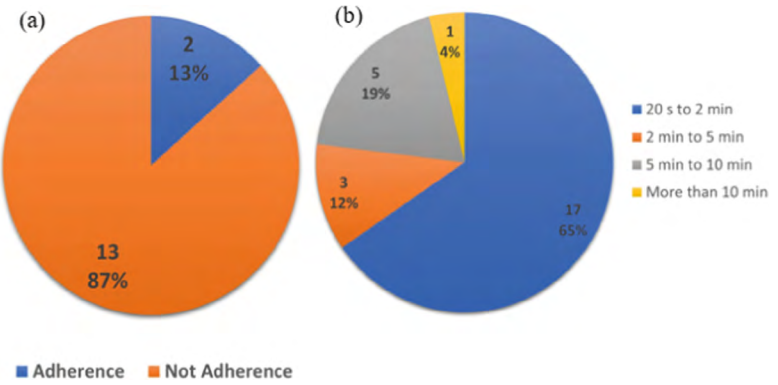


Fig. 3. (a) Adherence percentage and (b) time-lapse of the events on the second day.

3.4 Day 4. A Personal Feedback

As in day 3, the results of the previous day were presented in a pie chart to provide a feedback. The tags were not configured in silence mode, the adapted buzzers of the devices were to emit an audible alert in case of occurrence of an infraction of the policy. The results of this day were collected and processed for further analysis.

4 Experimental Results

After performing a careful analysis of the acquired data, the following results were obtained. Figure 4 shows the adherence and non-adherence percentage to the social distancing policy presented by the subjects per day. In days 1, 2, and 3 the non-adherence percentage is much more significant (having values that are greater than 80%), meaning that the social distance policy was not followed at all. On the fourth day, the non-adherence percentage dropped to 67% which can be attributed to the audible alert and represents a slight improvement However, even though the subjects had the knowledge (from day 2) that the experiment consisted of social distancing and even with audible alerts, the percentage of non-adherence is quite high (more than 50%).

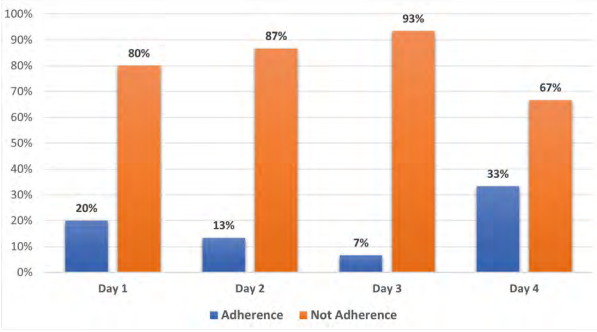


Fig. 4. Adherence percentage of social distancing policy per day.

Another relevant information obtained through the collected data is the number of events per day, i.e., how many times the social distancing policy was broken. This behavior is illustrated in Fig. 5. In the first two days we encountered a similar number of infringements. Considering that 15 people are part of the experiment we can infer that 80% of the subjects broke the social distance policy at least once. As for the third day, there is a significant increase in the number of events. Considering that, at the time, the subjects already known their role in the experiment and taking into account the feedback that was given to them; It was expected that the number of events will at least be maintained if not diminished. The number of events during the third day suggests a further analysis of the data. Activities that were not contemplated, such as a department meeting, could demand a group interaction and may justify the number of events. On the fourth day, the number of events drastically dropped to 15, this could be attributed to the audible alert the subjects heard whenever an event occurs.

As mentioned earlier, the system could be useful to help implement isolation protocols in case of an infection. To exemplify this feature, suppose the subject "06AC" has tested positive for SARS-CoV-2. The data collected by the tags allows to track every contact the subject has had with his/her coworkers during the past days. As shown in Table 1, the subject "06AC" interacted with subjects "9234" and "5B35" for a period of 260 [s] and 426 [s] respectively. Similarly, the interaction of subjects "9234" and "5B35"

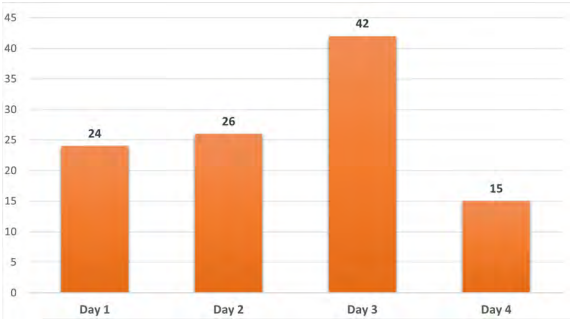


Fig. 5. Number of events per day.

can be tracked down. This allows for rapid response as well as for isolation protocols and, thereby prevents the increase of infectious cases.

Table 1. Tracking example of supposed SARS-CoV-2 case.

Tag ID	191C	C9B1	01B5	9234
1200	0	22	0	23
D9A8	0	0	0	0
D90D	23	0	0	0
5B35	0	0	0	**426**
06AC	0	0	0	**260**
901E	0	0	0	0
0C38	58	0	0	0

5 Conclusion

Social relationships between human beings are natural and necessary, but due to the SARS-CoV-2 pandemic big changes were demanded, especially in our behavior. In this paper, through this dedicated experiment, we presented the impact of a UWB based social distancing monitoring system on people's behavior. Specifically, we showed how the adherence percentage of the social distancing policy does not increase much even if the place has the proper signaling, indirect warn messages like self-care posters are showed, and direct warning messages like statistics about their behavior are presented. It is also showed that personal real-time feedback helps to increase the adherence percentage of the social distancing policy by 20% in the experiment. Finally, was presented the importance of this monitoring system due to its usefulness in people's isolation in case someone gets infected.

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Tools for Occupational Diseases Control in the Artisan Figures of Marzipan

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Abstract. A worker in an eight-hour workday is exposed to muscle aches or numbness in the legs and fatigue. Matrices were made for the identification and evaluation of physical risks to the population of artisans of marzipan figures in the parish of Calderon in Quito Ecuador, ergonomic evaluation methods were also applied such as: The RULA, Check list OCRA and the NIOSH equation. Five stages that make up the production process were identified: Preparation of the dough, kneading, shaping and finishing, varnishing, and drying, of all these stages the drying process is the most time consuming, the shaping and finishing stage is the one that more work and details requires, the kneading is in which a standing posture is maintained by the craftsman and with repetitive movements. It is necessary to implement a production system with well-defined phases, it is necessary to redesign the jobs that present a high level of ergonomic and physical risk, once the improvements proposed in the project have been applied, it is essential to maintain constant training with the artisans.

Keywords: Muscle aches · Marzipan · Ergonomic methods · Workstations

1 Introduction

Tourism in Ecuador has been developing a continuous expansion and diversification, becoming one of the economic sectors with the greatest development and growth [1]. The parish has a great diversity of cultural manifestations such as music, dance, gastronomy and the most important is the elaboration of the marzipan figures which is the most representative of the Calderon area in the capital Quito, being part of the cultural identity of this parish [2].

Perhaps, the work system is the central aspect of productive organizations and the one that most directly determines the characteristics of work activity and its potential physical and social risks [3]. Ergonomics has been used worldwide with the aim of improving the conditions in which a worker is with his station or workplace [4]. For the optimal design of a workplace, it is necessary to take into account all the elements that interact with the human being or the worker [5].

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 1034–1040, 2022.
https://doi.org/10.1007/978-3-030-85540-6_132

Musculoskeletal disorders (MSD) are the most common occupational disease in Europe; being repetitive movements the most prevalent physical risk factor (63%) [6]. The Ecuadorian Ministry of Labor recognizes that they are related to work, as a major occupational health problem that can be managed using an integrated ergonomics program for health and safety [7]. According to recent data from the Directorate of Work Risks of the Ecuadorian Social Security Institute (ESSI) dating from 2016, the professional conditions that were most reported were those of the muscular bone system [8].

The purpose of this work is the ergonomic evaluation, the same one that aims to detect the level of presence, in the evaluated positions, of risk factors for the appearance, in the workers who occupy them [9], it is necessary to obtain the level of exposure to ergonomic risks since, based on knowledge of critical situations, action is taken with the necessary corrective ways [10].

2 Methods

The ergonomic study was carried out on the artisans of the Calderon parish at the north of Quito city, in an organization that works with a tradition of more than 80 years that passes from generation to generation, mostly artisans are seniors people who are exposed to repetitive movements required by handicraft production activities [11]. To determine the stages of the process of making the marzipan crafts, a flow chart was used, which has the advantage of indicating the sequence of the process in it, the units involved and those responsible for its execution, that is, it comes to be the symbolic or pictorial representation of an administrative procedure [12]. The diagram should be drawn in such a way that the flow and operations of the process stand out immediately. This is accomplished by omitting all but the essential details, using arrows to indicate flow direction, using thicker lines for main flow lines, and indicating temperatures, pressures, and flow amounts at various significant points on the diagram [13].

Two risk matrices were elaborated since, this type of matrix allows to identify the most important activities of a company, the type and level of risk inherent to the activities and the endogenous and exogenous factors that generate these risks [14]. Subsequently the RULA method was applied to evaluate individual postures. To do this, it is necessary to observe the tasks that the craftsman performs and select the one with the highest risk or the greatest postural load, then divide the body into two groups, Group A which includes: arms, forearms and wrists and Group B, which includes: the legs, trunk and neck [15].

To evaluate the ergonomic risks in the kneading process, that is the one in which there are more movements in prolonged times and with a standing posture, the Check list OCRA method was used since it aims to alert about possible musculoskeletal disorders caused by repetitive activity in the workplace [16]. Marzipan artisans mostly use their upper limbs to make figures. At present, musculoskeletal disorders of the upper limbs are ranked second among the occupational diseases nationally reported, which affect a large part of the working population [17].

Handling and lifting loads are the main causes of low back pain. These can appear due to overexertion or as a result of repetitive exertion [18]. The result of applying the NIOSH equation is the Recommended Maximum Weight (RWL), which is defined as the maximum weight that it is advisable to lift under the conditions of the position to avoid the risk of getting this disease or problems. backwards [19]. In the case of artisans, they must lift approximately 4 kg every day repeatedly to start the kneading process, with the help of the NIOSH Eq. (2), it can be verified if that weight is adequate or exceeds the limit.

Table 1. Data for the application of the NIOSH equation

Weight	Vertical distance	Horizontal distance	Number of surveys	Time
4 kg	90 cm	18 cm	2	10 s

Table 1 refers to the weight of the pot with the water and the mass that add up to 4 kg, the vertical and horizontal distances that are an average of the measurements taken from three workers and the time that the worker holds the pot with the ingredients inside. The data were obtained after making ten observations that satisfy the sampling error.

3 Results

To carry out the Physical Risk Matrix shown in Table 2, measurements of noise, lighting, temperatures, vibrations and radiation were necessary. For the measurement of noise and lighting, a sound level meter and a lux meter were used respectively.

Table 2. Matrix of physical risks measured in the association of marzipan artisans in the town of Calderon

Risk	Applicable regulations	In which part of the process is the contaminant present	Measured values
Noise	Decree 2393. Art. 55. paragraph 7 [21]. NTP 270 noise evaluation	Varnishing of marzipan pieces carried out using a 1 HP 40-L motor air compressor	90.3 dB(A)
Illumination	Decree 2393. Art. 56 paragraph 1. NTP 211 lighting of work centers	Throughout the process of making marzipan figures	76 Luxes
Positive temperatures	Decree 2393 Art.53 y 54. Temperature between 17 °C y 27 °C	Present in the workplace environment varies according to the time of year	17 °C

(*continued*)

Table 2. (*continued*)

Risk	Applicable regulations	In which part of the process is the contaminant present	Measured values
Negative temperatures			
Vibrations	Decree 2393 Art.55 paragraph 8. NTP 839 Exposure to mechanical vibrations	Present in the kneading and varnishing process	0.33 m/s^2
	Hand-arm 5 m/s^2, whole body 1,5 m/s^2		
Non-ionizing radiation	Decree 2393 Art. 59 paragraph 1, Art. 60, 61. NTP 755 optical radiation, NTP 698 electromagnetic fields	Present in the workplace environment varies according to the time of year	13 UV índex

The RULA method divides the human body into two groups, Group A, which includes the upper limbs (arms, forearms, and wrists), and Group B, which includes the legs, trunk, and neck [20]. The score of group A in our case was 4 (Table 3) considering a twist of the wrist performed by the artisans, the score of group B was 5 see Table 4. With these values a extra analysis taking into account the variations that exist which will be added.

Table 3. Group C score for the RULA method

Analysis	Score
Group A score	4
Repetitive (repeats more than 4 times every minute)	1
Load between 2 and 10 kg held intermittently	1
Total	**6**

With the score of the group A = 4, we go on to analyze if there are variations in the task that can add up the score, in our case we find that the task is repetitive so a value of 1 is increased and the load is between 2 and 10 kg, so 1 is also increased. This gives us a total value of 6 that represents the value of group C as indicated in Table 3.

Once the value of B = 4 was obtained, we find the following variations: the task is repetitive so a value of 1 is increased and the load is between 2 and 10 kg so it also increases 1. This gives us as result a total value of 7 that represents the value of group D as indicated in Table 4.

Table 4. Group D score for the RULA method

Analysis	Score
Group B score	5
Repetitive (repeats more than 4 times every minute)	1
Load between 2 and 10 kg held intermittently	1
Total	**7**

The RULA method indicates that the values of A and B that were increased by the variations existing in the task, as was done in Tables 3 and 4, are now called C and D respectively. As the score of group C gave us 6 and that of group D was 7. In this case it can be said that the final score of the RULA is 7, which in turn represents a performance level of 4. That means, urgent changes are required in the task performed by the craftsman.

Calculation of the Check List OCRA Index:

$$\text{ICKL} = (\text{RF} + \text{FF} + \text{FFz} + \text{PF} + \text{FC}) * \text{DM}. \tag{1}$$

$$\text{ICKL} = (2 + 4 + 9 + 5, 5) * 0, 925.$$

$$\text{ICKL} = \mathbf{18}, \mathbf{9625}.$$

In Eq. 1 the value of the Check List OCRA index is calculated, which is equal to the sum of 5 factors: Recovery factor (FR), Frequency factor (FF), Force factor (FFz), Posture factor (PF), Additional risk factor (FC) and finally multiplied by a task duration multiplier (DM).

Table 5. Level of action according to the result obtained in the OCRA check list index

Analysis	Risk level	Recommended action	Score
≤5	Optimum	It is not required	≤1,5
5,1–7,5	Acceptable	It is not required	1,6–2,2
7,6–11	Uncertain	A new analysis or improvement to the position is recommended	2,3–3,5
11,1–14	Unacceptable level	Job improvement, medical supervision and training recommended	3,6–4,5
14,1–22,5	Medium unacceptable	Job improvement, medical supervision and training recommended	4,6–9
>22,5	High unacceptable	Job improvement, medical supervision and training recommended	>9

The result of the OCRA check list index calculated in Eq. 1 was 18.9; It is located in the range of 14.1 and 22.5. In other words, the level of risk is unacceptable and an improvement to the job, medical supervision and training is recommended according to what is established in Table 5.

NIOSH Equation Maximum Recommended Weight (RWL):

$$\mathrm{RWL} = \mathrm{LC} * \mathrm{HM} * \mathrm{VM} * \mathrm{DM} * \mathrm{AM} * \mathrm{FM} * \mathrm{CM}. \tag{2}$$

$$\mathrm{RWL} = 23\,\mathrm{kg} * 1 * 0.96 * 1.27 * 1 * 0.91 * 1$$

$$\mathrm{RWL} = \mathbf{22}, \mathbf{52\,kg}.$$

In Eq. 2 the calculation of the NIOSH Equation is performed, where LC is the load constant, HM is the horizontal distance, VM the vertical distance, DM is the vertical displacement, AM the asymmetry factor, FM frequency factor and CM the grip factor. All these are multiplying factors that take the value 1 in the case of a survey in optimal conditions, and values closer to 0 when the survey is further from the ideal conditions.

Lifting Index (LI):

$$\begin{gathered}\mathrm{LI} = \text{Lifted load weight/RWL} \\ \mathrm{LI} = 4\,\mathrm{kg}/25, 52\,\mathrm{kg}\end{gathered} \tag{3}$$

The value of 4 kg is equal to the weight of the pot that the craftsman handles, it contains water, flour and glue.

$$\mathrm{RWL} = \mathbf{0.16}$$

As the LI value calculated in Eq. 3 is less than or equal to 1, it means that the task can be performed by most workers without causing problems.

4 Conclusions

The tools for the control of occupational diseases in the artisans of marzipan, allowed the identification of physical risks such as exposure to noise over 90 dB or the lack of adequate lighting within the handicraft place, in addition it was possible to identify that the artisans are exposed to ergonomic risks related to repetitive movements and poor posture they adopt during their workday, which can lead to possible musculoskeletal disorders.

The results obtained from the risks lead to a restructuring of the job. The changes would be to provide the artisans with chairs and tables that can be adjusted to the height of each artisan, provide the artisans with hearing protection when they use the compressor to varnish the finished pieces, improve the lighting inside the workplace especially on work tables, take active breaks for every 2 h of work that include exercises focused on relaxation of the torso, neck and wrists, assign more people to carry out the kneading, shaping and finishing operations, as they are the ones that take the longest consume.

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Comparing the Efficacy of a Video and Virtual Reality Intervention to Mitigate Surgical Pain and Anxiety

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Abstract. Approximately 42 Americans die every day as a result of prescription opioids. Although controlled, opioids remain one of the primary pain management strategies after surgery. This research focused on comparing the efficacy of Virtual Reality (VR) and video interventions against standard care in mitigating preoperative anxiety and postoperative pain among 12 older adults (mean age = 61.5 ± 9.4 years, 8F, 4M) undergoing Total Knee Arthroplasty. On analyzing the survey response, both VR and video groups reported a reduction in pain and anxiety compared to no change among the control group. Further, both VR and video groups showed a significant increase (p-value = 0.01) in time-domain metrics of Heart Rate Variability (HRV), suggesting a decrease in anxiety. However, only the VR group showed a significant reduction (p-value < 0.01) in the frequency-domain metric of HRV and electrodermal activity, reflecting an increased parasympathetic activity. No significant differences were observed in postoperative opioid requirement.

Keywords: Virtual reality · Surgical pain and anxiety management · Prescription opioids · Heart Rate Variability

1 Introduction

Total Knee Arthroplasty (TKA), or knee replacement surgery, is one of the most commonly performed orthopedic surgical procedures, with over 800,000 TKAs performed annually in the U.S. [1]. These numbers are projected to increase by 335% to 3.48 million procedures by 2030 [2]. Advances in anesthesiology, including multimodal pain management protocols, have aided in decreasing hospital length of stay, requiring patients and their families to engage in postoperative care in the home environment [3, 4]. Opioids

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 1041–1048, 2022.
https://doi.org/10.1007/978-3-030-85540-6_133

remain one of the primary medications utilized for pain management during postoperative care, with prior studies reporting that approximately 80% of patients are discharged with opioid prescriptions even after a low-risk surgery [5]. Moreover, researchers have observed that the risk of chronic opioid use in the postoperative period is high among TKA patients, especially among patients over the age of fifty [6]. According to a 2018 Centers for Disease Control and Prevention (CDC) report, about 42 Americans die every day from overdoses involving prescription opioids, all of which point to a critical need for innovative strategies to mitigate postoperative pain among patients undergoing TKA surgery [7].

Postoperative pain is a complex phenomenon influenced by multiple factors, and both preoperative and perioperative pain levels are critical determinants with positive correlations to postoperative pain [8]. Apart from their influence on postoperative pain levels, elevated pre- and perioperative pain levels also have a negative impact on hospital length of stay, opioid requirements, and recovery time [9, 10]. Additionally, studies have reported preoperative anxiety to be an important contributor to perioperative and postoperative pain. It is estimated that more than 60% of patients undergoing surgery report elevated levels of anxiety in the preoperative setting leading to a higher risk of morbidity and mortality, requirements for anesthetics and opioids, and hospital length of stay [11–13]. Hence, it is critical to consider both preoperative pain and anxiety management while developing novel pain management strategies aimed at improving patient outcomes and reducing postoperative opioid consumption.

Distraction techniques, including music, videos, games, paced breathing, and virtual reality (VR), have been identified as effective techniques to mitigate acute, procedural pain and anxiety [14–18]. These techniques have been found to be efficacious during a variety of procedures, including venipuncture, burn wound dressing, intravenous catheter placement, blood transfusions, chemotherapy, etc. Distraction mechanisms work by engaging the user's attention and redirecting it from the perception of pain. Past studies have reported that the perception of pain requires an individual to pay conscious attention to the experience of pain, so redirection, therefore, helps block the brain's perception of pain [19, 20]. Additionally, humans have a finite amount of cognitive resources available for simultaneous mental processes, suggesting that any distraction method engaging multiple sensory systems may be more effective at capturing or redirecting a person's attention, reducing the perception of pain [21].

Numerous studies have investigated the efficacy of adjunct therapies in reducing anxiety and pain, and a few have compared the capability of one to another in mitigating pain. However, to our knowledge, none of the studies have compared the efficacy of a video and VR intervention in comparison to control groups in managing surgical pain and anxiety, especially among TKA patients. Additionally, very few studies have attempted to combine both self-assessment techniques with quantifiable biometric data to provide both subjective and objective assessments of pain and anxiety in this setting.

In this study, we randomized TKA patients into VR, video or control groups and provided a preoperative and postoperative intervention to identify the a) efficacy of each intervention compared to the control group b) impact of each intervention on the experience of perioperative anxiety, postoperative pain and, c) amount of opioids required in the postoperative period amongst all three groups.

2 Methods

2.1 Participants and Apparatus

Potential participants for this randomized controlled trial included patients undergoing TKA surgery aged 50 years or older. This particular population was selected as they have the highest risk of chronic opioid use in the postoperative period [6]. Patients were recruited approximately two weeks prior to surgery during an initial visit to a preoperative assessment clinic. Potential participants were provided details about the study along with potential risks, and interested participants were then screened for cybersickness using the Kennedy-SSQ [22].

Participants reporting a propensity for cybersickness were assigned to the control group, and others were randomized to the VR, video or control group. Except for one patient who reported a propensity for cybersickness, all the assignments in this study were random. Participants enrolled in this study included fifteen adults, two of whom had to be excluded because they did not meet age criteria and one participant who withdrew from the study prior to the intervention. Thus, our study included twelve adults (mean age = 61.5 ± 9.4 years, 8F, 4M) undergoing Total Knee Arthroplasty (TKA) at PRISMA Health Patewood Memorial Hospital Greenville, SC. The study was approved by the IRB of PRISMA Health under IRB Pro00074556, and participants received a $10 gift card upon completion of the study.

An HTC Vive Pro head-mounted device (HMD) was used to administer the VR experience, and an Asus ROG STRIX laptop with a 17.3-in. screen and 1920×1080 display was used for displaying the video intervention. A Biopac® BN-PPGED transmitter, electrodes, and BioNomadix® wireless logger were used to collect Heart Rate Variability (HRV) and Electrodermal Activity (EDA). The wireless logger stored the data as well as displayed real-time data collection. The logger was used to mark the start and end of interventions and other necessary events critical for analysis. This specific device was selected because of its efficiency in collecting high-quality data and the portability of the system. Both HRV and EDA data were collected at a sampling rate of 1 kHz.

2.2 Study Design

The video and VR groups received two interventions: a) preoperative – 30 min before surgery, and b) postoperative – 30 min before the first physical therapy session.

In the preoperative setting, the researcher met the participant in the surgery preparation room thirty minutes prior to surgery. The participant was first administered an 11-point Visual Analog Scale (VAS) and a State-Trait Anxiety Inventory-6 (STAI-6) to record their preoperative pain and anxiety levels [23, 24]. After completing the questionnaire(s), the participants were outfitted with the Biopac® BN-PPGED transducers and electrodes, which collected the EDA and HRV data. Participants were then asked to lie supine on the hospital bed, which was adjusted to the participant's comfort. Real-time data signals were observed using the BioNomadix® wireless logger to check the quality and mark any artifacts and unintended events. Five minutes of baseline data were collected for all patients, at which point a marker was recorded using the wireless logger to signal the end of baseline data collection.

In the case of control group patients, data were gathered for an additional 15 min to compare with the VR and video intervention groups. For the VR group, before placing the HTC Vive Pro HMD, patients were first familiarized with the VR hand controllers. The VR device was connected to an ASUS laptop, which mirrored the VR display, and the Cubicles Ninja Guided Meditation VR application was opened on the Steam VR application. This particular application was selected as our prior study found it efficacious in mitigating anxiety among cancer patients [25]. The researcher then outfitted each patient with the VR device, as seen in Fig. 1 below, and asked the patient to navigate through the app to make sure that they were familiar with the hand controllers. Each patient was then asked to make a few selections to start the VR session. Patients were allowed to explore the VR environment using the hand controller, and the researcher observed the patient's navigation using an Asus laptop. The beginning of the intervention phase was marked using the BioNomadix® wireless logger, with physiological measures recorded for 15 min, which marked the end of the VR intervention.



Fig. 1. A patient experiencing the virtual reality intervention

For the video group, an ASUS laptop was set up 30 in. away from the patient on an adjustable table. On the laptop screen, a guided meditation video that navigates the patient through a trail was displayed. All participants were provided headphones to listen to the accompanying audio soundtrack. As with the VR group, the intervention lasted for 15 min, and both the beginning and end of the intervention were marked.

After the VR and video interventions, data collection was stopped and, following the removal of the electrodes, participants were again administered the VAS and STAI-6 to record current levels of pain and anxiety. Although no intervention was provided for the control group, the same protocol was followed to stay consistent with the other groups. Additionally, participants in the video and VR groups were administered the I-group presence questionnaire (IPQ) to measure the spatial presence, realism, and involvement related to those respective interventions [26]. Finally, participants in the video and VR groups were asked to complete a first impression questionnaire to assess their attitudes and behaviors toward each of the systems that were administered.

In the postoperative setting, the researcher met each participant after completion of the surgery, 30 min prior to their first physical therapy (PT) session. This time was selected with the expectation that both pain and anxiety levels were likely to be impacted by the first PT session. Our goal was to therefore assess how each intervention would compare to the other and to the control group. The postoperative protocols were similar to the preoperative design for the three groups except that the participants in the video and VR groups were administered exit interviews after their intervention.

3 Results

To comprehend the effectiveness of our interventions in mitigating anxiety, we first analyzed the STAI-6 data. Because of the low sample size, variability amongst participants in the different groups, and data failing to meet the statistical assumptions, we decided not to perform a statistical test. STAI-6 scores vary from 20–80, where 20 corresponds to low anxiety, and 80 corresponds to high anxiety. The percent reduction in anxiety scores after intervention in the preoperative and postoperative setting for each group is represented in Table 1 below. The average STAI-6 score among the VR group was low (28) and reduced to the lowest score (20) following the VR intervention in the preoperative setting. Although the video group reported a higher decrease in anxiety scores than the VR group, it can be partially attributed to the fact that participants in the video group had a higher baseline anxiety score (41) and reduced to (25) after the video intervention. In the postoperative setting, both VR and video groups reported a similar reduction in anxiety after the intervention. Of note, participants in the control group demonstrated no change in anxiety scores.

Table 1. Change in percentage pain and anxiety after interventions.

Group	Preoperative		Postoperative	
	% reduction in anxiety	% reduction in pain	% reduction in anxiety	% reduction in pain
VR	26.5	30.0	35.9	45.5
Video	40.0	25.0	36.7	30.0
Control	0.0	0.0	0.0	0.0

Similar to anxiety data, we did not perform statistical analysis on the pain scores. As seen in Table 1 above, patients in both VR and video groups reported a reduction in pain after the intervention in both preoperative and postoperative settings. The baseline scores for all three groups were in the same range, and patients receiving the VR intervention showed a larger decrease in pain than the other groups suggesting that VR intervention could be more effective in mitigating pain than the video intervention.

Further, to comprehend the difference in opioid requirement among the three groups, we compared the opioid prescribed to patients. Comparison of the opioid data was facilitated using the CDC morphine milligram equivalence (MME) scale [27]. On average,

all three groups had a similar opioid requirement before the surgery and on the day of the surgery. However, on average, both VR and video patients required a higher opioid requirement in the postoperative setting. Again the high variability among the participants restricted performing a statistical analysis.

To compare the change in EDA levels measured as SCL, we performed a one-way ANOVA and observed significant differences among the groups. A Tukey post hoc test was conducted to identify differences among groups and observed that only the VR group showed a significant decrease in EDA activity compared to the control group (VR p-value = 0.01 & video p-value = 0.36). However, upon comparing the VR and video groups, no significant differences were observed in the EDA levels.

Similarly, a one-way ANOVA was performed, followed by Tukey post hoc to identify the changes in HRV metrics during the intervention. For the time domain metrics of HRV, comparing to the control group, both the VR and video group showed a significant increase in RR-Interval (VR p-value = .02 & video p-value = .05) and RMSSD (VR p-value = .04 & video p-value = .01) suggesting a decrease in anxiety. However, only the VR group showed a significant decrease in the frequency domain metric of HRV: LF/HF ratio compared to the control group (VR p-value = .03 & video p-value = .08), suggesting a significant increase in parasympathetic activity.

To understand the presence in the VR and video environments, we conducted a t-test on the data collected using the I-group presence questionnaire. The VR group had a higher I-group score and was significantly higher compared to the video group (p-value = 0.03), suggesting a better presence. Further, to identify the specific differences, we conducted a t-test on the individual components of the IPQ: spatial presence, realism, and involvement in the two environments. The VR group had a significantly higher spatial presence (p-value = 0.04) and involvement (p-value < 0.01) compared to the video group. However, no significant differences were observed for the sense of realism (p-value = 0.9).

4 Conclusions and Discussions

This research focused on analyzing and comparing the efficacy of a video intervention and a VR intervention in mitigating surgical pain and anxiety. Consistent with prior studies, we observed that both VR and video interventions were efficacious in mitigating surgical pain and anxiety [15, 28, 29]. These observations were supported by survey results as well as physiological measures, and findings further suggested that VR intervention be slightly more efficacious than video intervention. This observation was further validated from the I-group questionnaire, where the participants reported a higher spatial presence and involvement in the VR environment compared to the video intervention. However, when comparing the change in opioid consumption in the post-operative setting, both VR and video group patients required more opioids compared to the control group on the day after the surgery, suggesting that the long-term effect of distraction interventions on postoperative pain warrant further research.

This study had a few limitations, with the limited number of participants enrolled being the most obvious challenge as it relates to statistical analysis. We found patient recruitment to be challenging given that many of the patients in this surgical population expressed skepticism about the distraction methods being evaluated.

Additional research in this field could explore a variety of topics that might be beneficial in analyzing the role of adjunct therapies to diminish perioperative pain and anxiety. For example, the nature of video interventions and of the VR experience may play a role in reducing pain and/or anxiety. We anticipate that future studies will allow us to better understand both the mechanisms of how these distraction techniques can be employed and in what specific patient populations they may have the most benefit.

Acknowledgments. The authors thank Maher Ghalayini, Haleh Barmaki, Courtney Linder, Josh Biro and PRISMA Health staff at the Department of Orthopedic Surgery. The authors acknowledge the grant from South Carolina Research Authority #2012746 and PRISMA Health grants #2012600 and #2012672.

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Posture Determination of Wheelchair Caregivers Using Acceleration and Gyro Sensors

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Abstract. Japan's aging population is one of the highest in the world, and the need for nursing care is expected to increase more and more. Back pain accounts for more than 60% of all work-related illnesses, and by industry, the insurance and sanitation industry accounts for about 24% of the total. As the correlation between back pain and the physical load of moving and transfer care has been reported in the health insurance industry, measures to prevent back pain among caregivers are an urgent issue. In this research, we will develop a posture determination system for wheelchair caregivers. The system consists of an Arduino Uno and a 9-axis sensor module, and acquires data from acceleration sensors and angular rate sensors. The system is attached to the subject's body and evaluates the burden during the work operation based on the values of the accelerometer and angular rate sensor. In the experiment with different postures, the frequency of the sensor value exceeding the threshold value under the condition of forward leaning posture is 0.62, which means that the forward leaning posture is a slightly more burdensome posture. On the other hand, in the experiment with different inclinations, the frequency with which the sensor value exceeded the threshold value in the condition with an inclination was 0.78, indicating that the condition is quite burdensome. Furthermore, in the walking experiment with different walking speeds, the frequency with which the sensor value exceeds the threshold under the condition of fast walking speed is 0.40, indicating that the walking speed does not affect the physical burden during the work.

Keywords: Care · Wheelchair · Back pain · Posture · Acceleration sensor · Angular rate sensors

1 Introduction

Back pain accounted for more than 60% of all work-related illnesses in FY2009. In terms of the incidence of back pain by industry, the "insurance and sanitation industry (caregivers and nurses)" accounted for about 24% of the total, surpassing the "transportation industry" and "construction industry" [1]. As risk factors for the occurrence of low back pain, the following were cited in relation to work activities; 1) Bending the body back and forth, 2) Twisting the waist, 3) Pushing or pulling objects or people. The longer the time spent engaging in these activities, the higher the grade of back pain that develops

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 1049–1055, 2022.
https://doi.org/10.1007/978-3-030-85540-6_134

[2]. In the health insurance industry, a correlation between back pain and the physical load of moving and transfer care has been reported [3].

It can be seen that back pain, which is regarded as a national disease in Japan, is causing problems in the health care industry. In addition, not only professionals but also many citizens have the opportunity to be involved with those who need care as caregivers. Therefore, it is necessary to prevent the risk of back pain in advance by adopting a posture that places less burden on the lower back in nursing care work. On the other hand, it is still unclear what kind of posture is used by caregivers and nurses who do not suffer from back pain. The current methods for preventing back pain include "improving the posture of the caregivers, securing sufficient work space, and understanding and cooperation of facility directors and managers [4]. However, these measures are artificial and may not always be possible to implement. Therefore, it is necessary to measure the posture during actual nursing care and clarify the relationship with risk factors.

Examples of utilization of analysis using accelerometers and gyroscopes include estimation of walking trajectory [5], evaluation of energy usage [6], measurement of acceleration during running [7], and estimation of joint angles of lower limbs [8]. The merit of all of these is that it is possible to construct an inexpensive measurement system. Points to be considered for practical use of the system include the number of measurement sites and the fact that the subject's movement should not be constrained. There are also studies using optical motion capture for motion and load analysis in nursing [9]. Optical motion capture has the advantage of being able to measure body movements in more detail than sensors, but it has problems such as the need to install multiple cameras in a hospital room.

When assuming that the system will be used in hospitals and other facilities for the purpose of preventing back pain in healthcare workers, the use of a sensor that can be easily attached to work clothes and supporters without the need for multiple devices can lower the threshold for introducing the system.

Therefore, this study focuses on wheelchair assistance and examines a posture determination system for wheelchair assistants, based on the need to prevent the risk of back pain in nursing care work and the results of a survey showing that wheelchairs are the most commonly used type of welfare equipment [10]. In particular, in the experiment, we will collect measurement data from acceleration and gyroscopic sensors attached to the body, and examine the factors that affect the increase in workload.

2 Proposed Method

2.1 Posture Assessment System

Figure 1 shows the posture assessment system for preventing back pain in wheelchair caregivers. This system judges the posture that is burdensome when assisting wheelchairs based on the sensor information read, and notifies the caregiver when the posture is evaluated to be burdensome to encourage posture improvement. In this research, the sensing part → data aggregation → cloud computing (analysis, estimation, and judgment) is performed. The threshold values used in the analysis, estimation, and judgment were calculated using spreadsheet software from the collected data, but in the future, we aim to implement analysis, estimation, and judgment using machine learning.

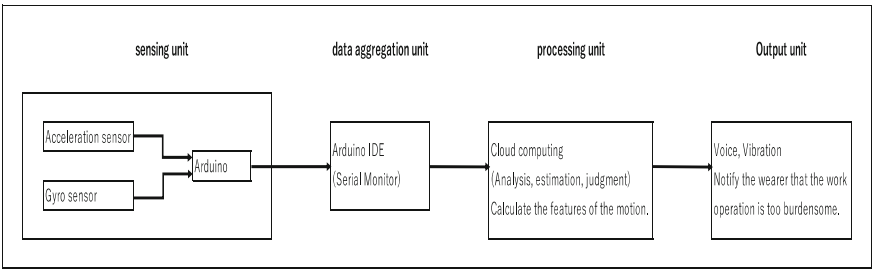


Fig. 1. System configuration

2.2 Sensing Part (Data Collection Section)

In order to measure the movements of the wheelchair-bound caregiver, we used three BMX055 9-axis sensor modules manufactured by Akizuki Denshi Tsusho Co. Of the data that can be acquired, only acceleration and angular velocity data are used in this system.

We chose Arduino Uno to control each sensor and acquire the measurement results because of its ease of use and programming.

The data acquisition system was configured using Arduino Uno and a small base. To reduce the size of the device, the Arduino and the base were placed on top of each other. The power supply for the Arduino is provided by a direct USB connection to the PC.

For ease of implementation, data was recorded for each test using serial communication through a direct connection to the PC.

2.3 Wearing of Sensor

The sensors and peripherals were mounted on the ventral region, thighs, and shins for upper and lower body motion measurements. The device attached to the ventral region was placed in a commercially available plastic case for storage and fixed to a belt for attachment. For the devices on the thighs and shins, a rubber band was threaded through a hole in the plastic case that came with the Arduino Uno.

The measured values of the accelerometer and angular rate sensor, the amount of change in the X-axis, and the amount of change in the Z-axis can be used to evaluate forward and backward movement, and left and right movement, respectively.

The Y-axis of the accelerometer and angular rate sensor is located parallel to the right side of the body, where the device is mounted, and is not necessary for the evaluation of the target motion, so the measurement results are omitted.

3 Experimental Methods

3.1 Setting up a Walk Test

A simulated nursing care task was created using a wheelchair, cardboard boxes filled with plastic bottles weighted with sand and water. One male subject in his twenties will

be tested to walk in a straight line while pushing a wheelchair. The walking starts with the right foot and ends with the left foot grounded at the 30th step. In this experiment, we will compare the measured data of the following four items, which are considered to be possible factors causing back pain during wheelchair assistance: "caregiver's posture," "slope of the road," "walking speed," and "weight of luggage". The four items are set as follows:

Item (1) Posture of the caregiver (Correct posture (back stretched), forward leaning posture (back rounded)
Item (2) Slope of the road: No slope, Yes slope (about 10% slope uphill)
Item (3) Walking speed
Item (4) Weight of luggage

The average walking speed of the subjects measured in advance was 81.5 [step/min] when they walked slowly, 102.0 [step/min] when they walked at a natural speed, and 123.5 [step/min] when they walked fast. Therefore, in this experiment, the speed of pushing the wheelchair is 80 [step/min], 100 [step/min], and 120 [step/min] for comparison. In order not to cause a drastic change in the walking speed, the subjects will use earphones and listen to the tempo sound from the metronome application of the smartphone while conducting the test. The weight of the cardboard boxes to be placed on the wheelchair as a substitute for the person requiring care in this experiment is 0 kg (without anything in it), 67 kg (assuming the average weight of an adult male), and 33.5 kg (for comparison: 67 kg × 0.5) (Table 1).

Table 1. Identification result test pattern (combination of items)

	Experiment number	Pattern	Attitude	Inclination (slope)	Walking speed [step/min]	Weight [kg]
①	Compare postures	A	Correct posture	Without	100	33.5
		B	Forward leaning	Without	100	33.5
②	Compare inclination	A	Correct posture	Without	100	33.5
		B	Correct posture	With(10 %)	100	33.5
③	Compare walking speed	A	Correct posture	Without	80	33.5
		B	Correct posture	Without	120	33.5
④	Compare weight	A	Correct posture	Without	100	0
		B	Correct posture	Without	100	67

3.2 Method for Determining and Evaluating Threshold Values

In this experiment, the sensor values obtained by the devices used are analyzed by creating a line graph using EXCEL. In this experiment, the total number of peak values (peaks and troughs of the line graph) of the data to be compared is calculated, and then each experimental condition is evaluated by the percentage that exceeds the threshold value derived from the reference data. The judgment result is 0.0 to 1.0. If the result is close to 1.0, it is judged that the test condition of pattern B (6th to 7th) tends to act to increase the burden of work operation compared to the test condition of pattern A (1st to 5th).

4 Experimental Results

As an example of the measurement results of each walking test, the following graphs show the results of the posture comparison experiment when leaning forward. For Figs. 2 and 3, the horizontal axis is elapsed time [sec] and the vertical axis is acceleration [G] and angular velocity [deg/sec].

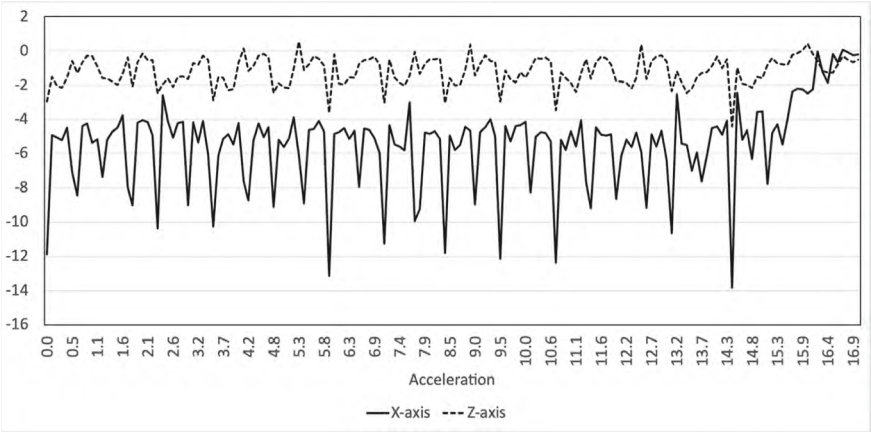


Fig. 2. Example of acceleration sensor measurement results (forward leaning posture)

The total number of peak acceleration and angular velocity graph values obtained from five tests in the forward leaning posture was 5832. The total number of peak acceleration and angular velocity graph values obtained from five tests in the forward leaning posture was 5832, of which 3615 exceeded the threshold value, and the result expressed as a percentage was 0.62. Therefore, it can be concluded that wheelchair transfer assistance in the forward leaning posture is a slightly more burdensome task compared to the upright posture.

As a result of conducting walking tests with different road inclinations, the total number of acceleration and angular velocity graph peak values obtained from five tests in the case of road inclination was 5724. The total number of acceleration and angular

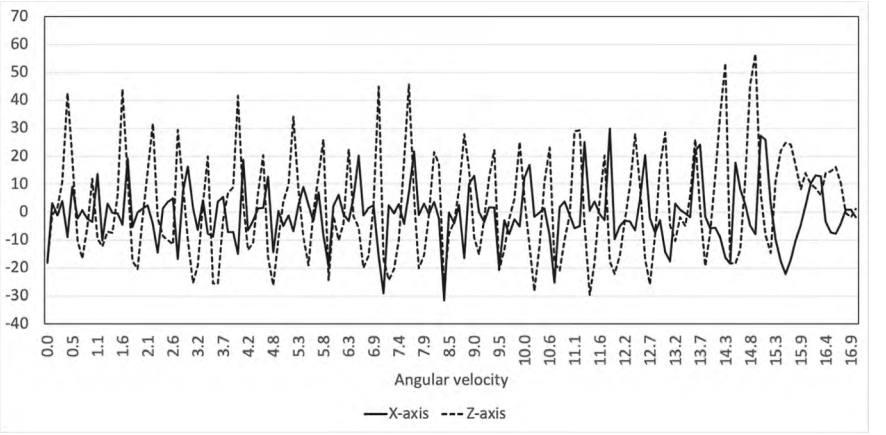


Fig. 3. Example of angular rate sensor measurement results (forward leaning posture)

velocity graph peak values obtained from five tests with a road inclination was 5724, of which 4465 exceeded the threshold value, resulting in a judgment result expressed as a percentage of 0.78. Therefore, it can be concluded that wheelchair transfer assistance in the case of an incline is a more burdensome task than in the case of no incline.

Table 2. Judgment result

Experiment number	Experimental conditions	Judgment
① Compare postures	Correct posture	0.47
	Forward leaning	0.62
② Compare inclination	Without	0.57
	With	0.78
③ Compare walking speed	80[step/min]	0.43
	120[step/min]	0.40
④ Compare weight	0[kg]	0.48
	67[kg]	0.72

The total number of peak acceleration and angular velocity graph values obtained from the five tests at a walking speed of 120 [steps/min] was 5632. Of these, 2259 were above the threshold value, and the judgment result expressed as a percentage was 0.40. Therefore, it can be concluded that walking speed does not affect the degree of burden of wheelchair transfer assistance.

As a result of conducting walking tests with different luggage weights, the total number of peak acceleration and angular velocity graph values obtained from five tests with 67 kg of luggage was 5748. The total number of acceleration and angular velocity

graph peak values obtained from five tests with 67 kg of luggage was 5748, of which 4142 exceeded the threshold value, and the judgment result expressed as a percentage was 0.72. Therefore, it can be concluded that wheelchair transfer assistance is a more burdensome task when the subject's weight is heavy than when the subject's weight is light (Table 2).

5 Conclusion

In this study, we proposed a system to measure the physical burden caused by posture and work environment from acceleration and angular velocity sensor information during wheelchair assistance, and verified its effectiveness through a mock nursing care experiment. As a result, it was estimated from the measurement results of the acceleration and angular velocity sensors that the causes of physical burden on the caregiver during wheelchair assistance are (1) forward leaning posture, (2) inclined road conditions, and (3) high weight.

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Mastication Detection Method by Chin Movement Using Image Processing

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Abstract. Our ability to bite and swallow declines with advancing age, and the risk of aspiration increases. In this study, as premises for the development of an aspiration prevention system, we will detect mastication by chin movement from moving images. At the same time, we will count the number of times that a person masticates simply, and think about validity of this method. In order to detect mastication, we focused on the time variation of the distance between the point at the tip of the nose and the chin. First of all, we start to detect face organ points. From them, the distance between the two points is calculated for each frame. When it exceeds the threshold, it is regarded as the mastication. At this time, we apply a moving average in order to increase the robustness of outliers. As a result of the experiment, the detection frequency of "mastication as usual" were close to the actual frequency. Similarly, it can be said that we could detect "mastication slower than usual" almost exactly. However, violent noises occurred frequently in "mastication faster than usual". They are thought to be the aftereffects of the blurring of the image caused by the intense movement of subjects in the stage of detecting the face organ points. Besides, unclear chin movement made the detection difficult.

Keywords: Image processing · Aspiration prevention · Mastication detection

1 Introduction

As we age, our ability to bite and swallow declines, and the risk of aspiration increases. The impairment of masticatory ability and swallowing function develops deglutition disorder. Deglutition disorder causes aspiration [1]. In Japan, about 4,000 people die from aspiration annually, including 2,500 people over the age of 80. Accidents caused by aspiration are expected to become a social problem in the future as the population ages [2].

Mastication is the action of crushing ingested food with teeth in order to change form for swallow [3]. The methods of examining masticatory ability are roughly divided into two types: direct and indirect [4]. Direct examining method includes evaluating the condition of chewed mastication samples as objective numerical values. In contrast, there

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 1056–1062, 2022.
https://doi.org/10.1007/978-3-030-85540-6_135

are two methods of indirect examining: one is to judge from the mandibular movement during mastication and the other is to judge from muscle activity during mastication. Among them, the method to judge from the mandibular movement is to evaluate masticatory ability by chewing a sample of mastication, measuring the movement of incisor point at that time, and analyzing the movement path, movement rhythm, and movement speed. The movement path and the stability of movement rhythm are highly correlated with masticatory ability. Therefore, it is expected that detecting mastication and counting mastication frequency will be completed, which will be of some help to the evaluation of masticatory ability.

In the preceding study, they considered three methods for counting the chewing number using small pressure sensors [5]. The first one is the chin strap detection method in which the system detects the small expansion of the chin strap with strain gages when one chews food. The second is the ear plug detection method using a strain gage or a semiconductor pressure sensor. In this method, the small strain of the ear plug is detected by these sensors. The third is the head detection method in which the system detects the small expansion of the temporal muscle using the head band with a semiconductor pressure sensor. These systems can detect the chewing power.

The method using myogenic potential is generally to judge masticatory ability from electromyogram (EMG) [6]. Parameters like the duration of discharge, interval and average amount of change are obtained from EMG of chewing muscle. The stability of mastication rhythm is evaluated by them to judge mastication ability.

There are approaches to using image processing. According to the study by Abe and others, they developed a real-time eye blink counter system [7]. This system employs face pattern recognition, eye-area detection, and tracking using a template-matching method for eye blink detection. Kuwahara and others published a similar study [8]. Anyway, Miyanaka and others tried to develop a noncontact chewing cycle analyzer which works on tablet PCs by reference to the study Abe and others released [9, 10]. After a face area captured, the top far-left pixel was tracked to measure the whole face transition and two pixels at the captured mouth angle were picked up to measure the optical flow method. The mouth movement in the period of food intake, mastication and swallowing, was recorded. The optical flow is a set of vectors that represent the motion of an object using a time-continuous image. By graphing the waveform of the repeated movement caused by the opening and closing movement of the lower jaw, we have developed an application that allows us to see the amount of movement of the lip area during mastication, its changes, and individual differences. Although the method in this previous study detects mastication by focusing on the amount of movement of the lip area, we believe that it is insufficient to accurately detect mastication by using only the mouth and lips because there are cases in which mastication occurs with the mouth closed. Therefore, in this study, we are examining a method to detect mastication by focusing on the chin movement.

The following is a summary of the above. In general, mastication ability decreases with aging, and it stands in the way of meals. In particular, elderly people are at high risk of aspiration. It leads to death if the worst happens. Thus, it is important to properly chew their food. The main purpose of our study is to develop a system to prevent aspiration in elderly people. We believe that there is some correlation between aspiration and chewing ability, and as a preliminary step, we propose a system that detects chewing from chin movements and simultaneously measures the number of chews.

2 Proposed Method

A flow of our proposed method is shown in Fig. 1. There are two general phases: the learning phase and the detection phase.

In the learning phase, 2,000 face images are captured from the Helen dataset, and the Histograms of Oriented Gradients (HOG) and Haar features are extracted using dlib and OpenCV [11, 12]. HOG is calculated by the distribution of luminance gradient direction. Then, the face shape is represented as a vector, and the shape difference from the teacher data is obtained. From these shape differences, an algorithm called Gradient Boosting is used for learning.

In this study, we focused on the time variation of the distance between the points at the tip of the nose and the chin in order to detect mastication and count mastication frequency.

In the detection phase, first of all, human faces are recognized by 194 face organ points. From the detected face organ points, the distance between the two points for each frame is calculated. When it exceeds the threshold, it is regarded as the mastication. At this time, we apply a moving average in order to increase the robustness of sudden outliers.

3 Experimental Method

We have 6 subjects eat rice balls and try 3 kinds of ways: (1) 8 times of the mastication as usual, (2) 8 times of the mastication slower than usual, and (3) 8 times of the mastication faster than usual. We shoot videos with a smartphone (iPhone 11).

Experimental environment is shown in Fig. 2. In this experiments, we use a chair, a camera and a tripod. The height of the chair above the ground is 40 cm from the actual measurement, and the height of the camera is 120 cm. In addition, the distance between the camera and the chair is set to 250 cm, assuming that this system would be used for real. The camera is used at 2.5-fold magnification so that the entire face of the subject could be clearly captured. The camera is focused on the subject's chin area and the videos are recorded at 30 frames per second.

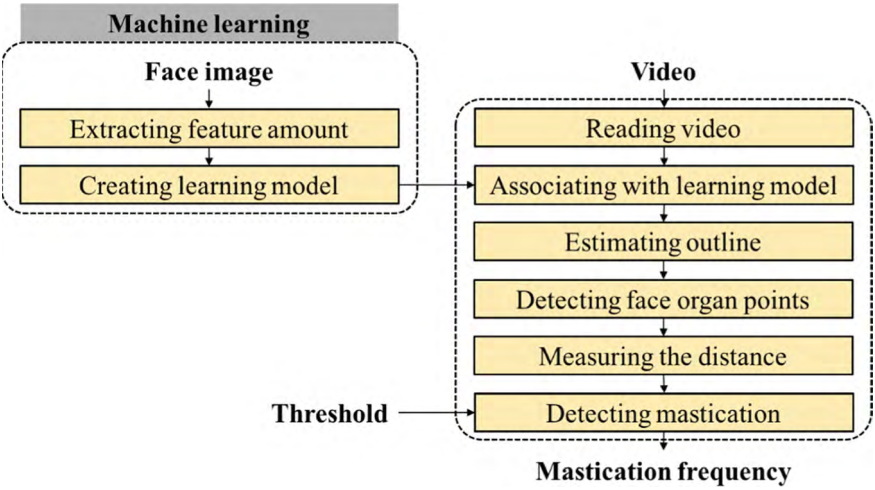


Fig. 1. Proposed method

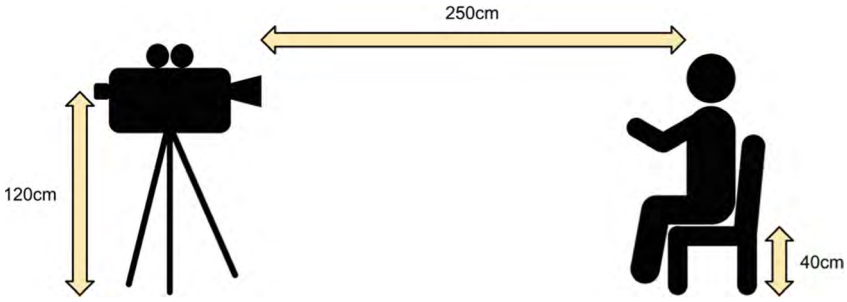


Fig. 2. Experimental environment

4 Experimental Results

Experimental results of counting mastication frequency are shown in Tables 1 and 2. Furthermore, the chin movement of a certain subject are shown in Figs. 3, 4 and 5. By calculating the moving average, graphs are smoothed to a degree.

Table 1. Experimental results of "fixed threshold"

	Mastication as usual	Mastication slower	Mastication faster
Average	8	9.17	6
Standard deviation	0.58	1.95	2.31

Table 2. Experimental results of "optimal threshold"

	Mastication as usual	Mastication slower	Mastication faster
Average	8	8.8	8.83
Standard deviation	0.58	0.98	1.06

Incidentally, "fixed threshold" is decided on the basis of "mastication as usual" on each subject. At first, we set the threshold in "mastication as usual" to become close to the actual frequency. Then, in experiments with "mastication slower than usual" and "mastication faster than usual", the same threshold is used. On the other hand, "optimal threshold" is set intentionally on each subject and each kind by graphs in order to get ideal numbers. When the distance between the nose and the chin exceeds the threshold, we considered the movement as the mastication.

Comparing Tables 1 and 2, when we use "optimal threshold" can detected more accurately than when we use "fixed threshold". As in Tables 1 and 2, the detection frequency of "mastication as usual" were close to the actual frequency in common. Similarly, we can detect "mastication slower than usual" almost exactly. However, large noise frequently appeared for "mastication faster than usual". As Fig. 5 shows, especially, there is violent noise at around 90th frame. This is thought to be due to the blurring of the image caused by the intense motion of each frame in the stage of the face organ points. Moreover, as we can see in Fig. 5, low amplitude made the detection difficult. This is caused by unclear chin movement.

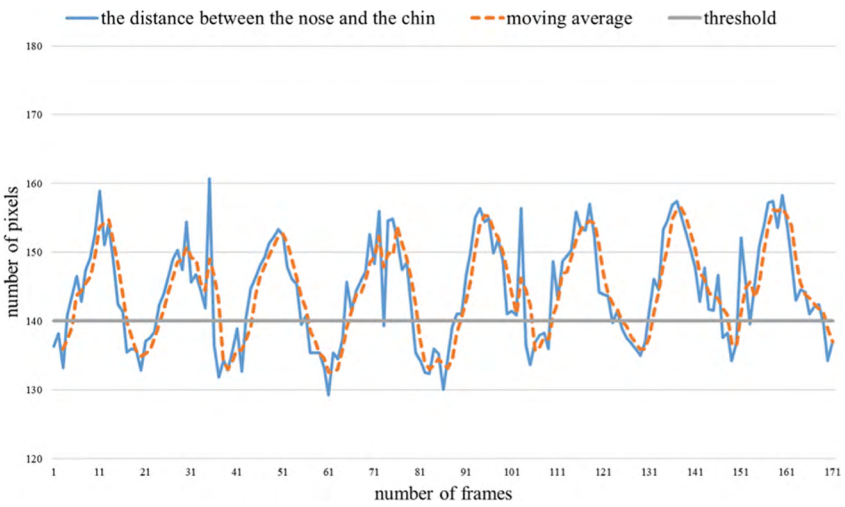


Fig. 3. A graph indicating experimental results of "mastication as usual"

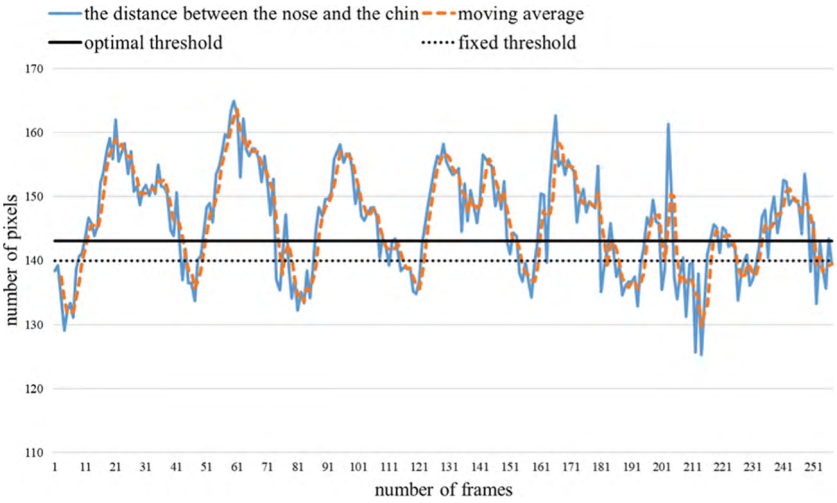


Fig. 4. A graph indicating experimental results of "mastication slower than usual"

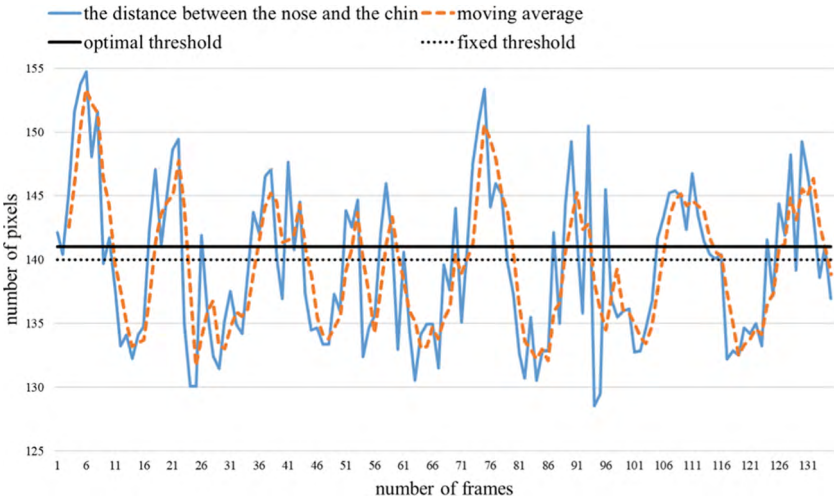


Fig. 5. A graph indicating experimental results of "mastication faster than usual"

5 Conclusion

In this study, we proposed a system to detect mastication by chin movement using image processing and count mastication frequency. From experimental results, we achieved some positive results in the case of "mastication as usual". On the other hand, large noise was frequently generated for "mastication faster than usual". In particular, "mastication faster than usual" tended to be difficult to detect due to its small amplitude in addition to the noise.

In the future, we need to improve the processing speed and think of a way to set the threshold. Also, if we can detect the direction of the face and distinguish between jaw movements for conversation and mastication, we will be able to complete a better system.

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Motor Imagery Training Improves Reaction Time in Mouse Aiming Task

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Abstract. Motor imagery training is commonly used for sport and neurorehabilitation, improving human motor performance. In our previous works we have shown that motor imagery can be an effective way to reach higher performance in some sensorimotor tasks, technically related to esports. In this work reaction time of 10 participants was measured in the mouse aim task before and after motor imagery training session, while EEG was recorded. Statistically significant decrease in reaction time between before and after motor imagery training was obtained, while stable contralateral central ERD patterns during motor imagery were presented. A high correlation between baseline reactions' time of participants and their levels of progress was observed. We believe that motor imagery training associated with sensorimotor rhythms desynchronization in EEG has great potential for esports training programs.

Keywords: Motor learning · Human-computer interaction · Neuroplasticity · Mental training · Motor imagery · Esports

1 Introduction

Motor imagery training (MI-t) is widely used in the sport training process [1, 2] and neurorehabilitation [3]. In particular, it was shown that MI-t can improve motor performance [4], muscle strength [5] and joint flexibility [6]. There are works showing that MI-t can lead to shortening of the reaction time in sensorimotor tasks [7–9]. Particularly, there was demonstrated the improvements in the performance time in visuomotor grasping tasks, as a result of motor imagery practice [7]. Also there has been shown enhancement of performance in mouse-cursor task [8] and complex arm-pointing task [9] which both required speed and high spatial accuracy. Despite the data that testify motor imagery improvement potential for motor learning in sensorimotor tasks, all these studies were performed without any neuroimaging technique to control the quality of mental motor images. Nonetheless, the absence of a way of assessing the motor imagery quality is a crucial disadvantage towards understanding the mechanisms of motor imagery and its effects. According to the information, we conducted our latest study [10], which has shown that kinesthetic motor imagery, which is associated with sensorimotor event

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 1063–1068, 2022.
https://doi.org/10.1007/978-3-030-85540-6_136

related desynchronization (ERD) in EEG, leads to the reaction time improvements in computer mouse speed clicking tasks. The movements used in that study required just finger clicks on a mouse button, while in this study we decided to examine more complex movements including spatial manipulating with the mouse by wrist and finally clicking by the index finger.

The aim of the study was to evaluate the effect of motor imagery training on reaction time in gaming mouse hovering for future use in e-sport training. This work is a second step of studying the potential of motor imagery for e-sports needs and is a part of BCI training platform development called «e-boi».

2 Methods

The study involved 10 healthy volunteers asked about their video gaming experience, gaming skills, frequency of gaming sessions and types of games usually played by participants. All the participants signed an informed consent according to the declaration of Helsinki.

The mouse aiming task was performed in the «e-boi» platform before and after 40 min of MI-t. Participants had to aim and click quickly and accurately on the targets on the computer screen. The targets were disappearing and appearing on randomly selected parts of the screen. Misclicks were not logged. Participants had 2 sessions before and 1 after MI-t. The first session, called “baseline” lasted 1 min and was given to get used to the computer and rules of the task. The second one “before” session lasted 1.5 min and the participants were instructed to reach high motor performance while were thinking about their movements and sensory feelings. And the third session made after MI-t also lasted 1.5 min.

During the MI-t the participants had their right hand on the mouse and index finger on the left button, while the images with multiple circle shaped targets were being shown to them. Participants were asked to imagine right hand movements relevant to the performing task – hover movements of the wrist with consequent mouse clicks. The session included the sensorimotor resting state where a picture with abstract visual content was shown. Since the patience and high mental concentration were needed during motor imagery trials, volunteers had the possibility to request breaks between them.

Simultaneous 30-channel EEG was recorded at 500 Hz sample frequency in range 1–70Hz during MI-t. Raw data were preprocessed using bandpass filtration (1–30 Hz, Butterworth 4th order), spatial filtration (Common Average Reference) and epoching according to the experimental condition (motor imagery, rest). Spectral analysis (Fast Fourier transformation in 1 s window with overlapping 85% and spectral power density calculation using Welch method) was applied on EEG epochs lasting 6 s. ERD values were calculated based on individual sensorimotor subranges (~7–13 Hz) between 2 conditions (motor imagery and sensorimotor rest) for each channel and then mapped into 2-d head layer.

Statistical analysis included paired comparisons for reaction time between baseline, before and after experimental conditions using Friedman test, Wilcoxon signed-rank tests with subsequent Bonferroni correction. Correlation was estimated using Spearman rank correlation.

Stimulus presentation and recordings were performed by «e-boi» software. Data analysis and visualization carried out using python packages (MNE, pandas, SciPy and seaborn) in self-written scripts [11–13].

3 Results

All the subjects demonstrated sensorimotor desynchronization reaction in EEG over the central group of channels during MI-t (Fig. 1). ERD was especially expressed contralaterally in relation to an imaginary hand that corresponds to channels CP1, CP3, P3. The severity of ERD was different intersubjectly, however spatial ERD patterns arrangement was common among the participants and located in C-CP channels in the left hemisphere.

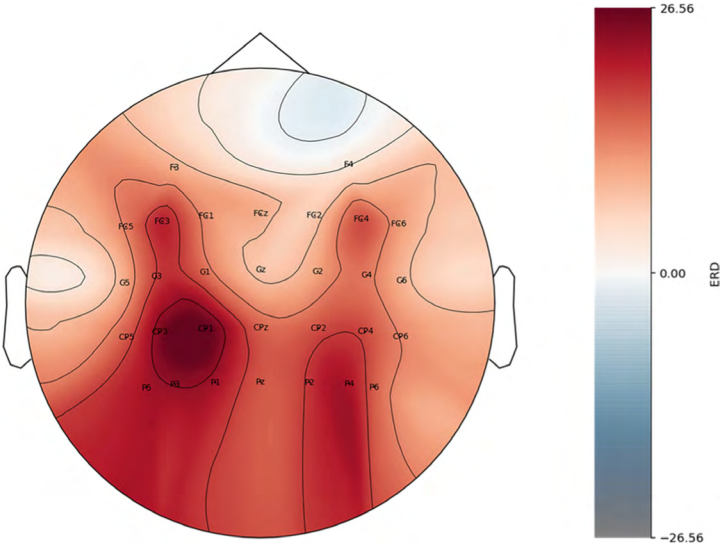


Fig. 1. Median average sensorimotor ERD patterns during MI-t (N = 10). Dark red shades correspond to high ERD level, while lighter shades of red correlate with the less level of desynchronization. Blue shades correspond to event related synchronization (ERS).

Statistically significant changes ($p = 0.037$) in the reaction time before and after MI-t were obtained, while there were no significant changes ($p = 0.48$) between "baseline" and "before" motor performance measures. Also, statistically significant high level of correlation ($r = 0.7, p = 0.023$) was obtained between reaction time on "before" measures and average level of motor imagery efficiency (was estimated as the percentage of change after MI-t to the state before).

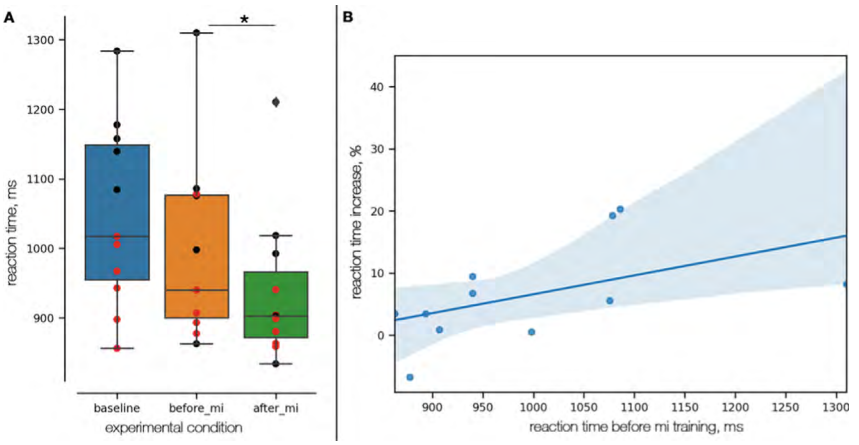


Fig. 2. A. Group reaction time (ms, N = 10) measured in "baseline" (acquaintance with the software), "before" (before MI-t) and "after" (after MI-t) motor performance sessions. The asterisk corresponds to $p < 0.05$ (Bonferoni adjusted). B. Correlation of average reaction time in "before" measures (ms) with level of MI-t efficiency (%). $r = 0.7$; $p = 0.023$. Each dot represents one subject, the solid line depicts linear regression. Blue area corresponds to confidence interval = 95%.

4 Discussion

The Subjects demonstrated stable contralateral ERD of sensorimotor rhythm during MI-t sessions and the ERD was higher in central/parietal channels. It corresponds with previous research showing presence of desynchronization patterns in these regions either during motor tasks, or motor imagery tasks. [14–16]. The mu-desynchronization over the sensorimotor cortex regions indicates the fact that our participants performed kinesthetic motor imagery during mental training.

We assume that the MI-t associates with activation of the neural circuits and cognitive pathways participated in the motor as in physical training. According to the research data, the effects of motor imagery are realized at the cortical level [17]. Thus, we confirm that motor imagery impacts on brain circuits only and MI-t efficiency can be associated with the activation and training of cortical neurons and motor paths [7, 8]. We observed the significant improvement of the average reaction time after MI-t sessions (Fig. 2A). At the same time there were no significant changes in the reaction time between "baseline" and "before" measures. However, small changes may occur as the result of habilitation to the software. In further studies we are going to introduce a control subgroup to compare the effects of kinesthetic MI with visual imagery and physical training.

The average-high correlation between "before" reaction time and the efficiency of MI-t is associated with the potential threshold of the motor activity of unprepared volunteers: we believe that people with low reaction have higher possibilities to improve their motor skills. This hypothesis may be confirmed according to visual analyses of the Fig. 2A, where we can see that the "after" results have less outlining measures and the highest density. Therefore, MI-t improves peoples' results to a common level. Motor

reaction time is limited by motor neuronal path, which includes cortical and spinal neurons [18], and repeating MI-t sessions contribute to the achievement of this physiological threshold.

In recent studies it was hypothesized beneficial effects of MI-t for complex actions training [7]. Here we studied the "aim and click" task, which requires muscles' movements of only one arm. At the same time successful completion of this task includes not only high-speed reaction, but also high motion control (speed-accuracy tradeoff). Further we are planning to study the trajectories of computer mouse movements before and after MI-t to explore the effect on the reaction speed and motor control more precisely.

5 Conclusion

This study was performed as a part of the e-boi training platform development for e-sports. We believe that MI-t with neurofeedback based on ERD activation patterns in EEG can be effective for e-athletes training and the obtained results are applicable for the development of the supplementary training approaches for e-sports. It is necessary to study the variety of the effects of MI-t for different types of movements (e.g. keystrokes) and sensorimotor tasks involved in the natural gaming process. These studies can be helpful for the development of the new generation of BCI training systems for e-sport purposes and also can be implemented in traditional sport practice, neurorehabilitation and other ways based on motor learning.

Acknowledgments. The work was carried out within the framework of state research grant № FZWM-2020-0013.

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Production Management Model for the Evaluation of Operator's Posture-Base Measurement and to Redesign Work Area to Improve Labor Productivity in a Manufacturing SME

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Abstract. Over the years, manufacturing companies have become an influential factor in the country's economy, 95% of them being small and medium-sized companies. However, many are not competitive due to low labor productivity that affects their production levels and the fulfillment of their demand; Furthermore, they lack the knowledge or resources to solve these problems. This research was carried out in view of the need to take advantage of human resources in a manufacturing SME, for which a micro-level production management model was proposed aimed at improving the production area by evaluating the anthropometric posture-base measurement of the operator, redesigning the production area and conducting a time study to improve the company's labor productivity. Through the simulation in the Arena software, an increase in labor productivity was achieved by 25%.

Keywords: Anthropometry · Plant distribution · Labor productivity · Manufacturing sector · Production area

1 Introduction

Taking advantage of human resources is essential for which the labor market must be efficient to boost competitiveness, however, not all countries are in a position to provide an adequate labor market. Worldwide, Singapore was the country that increased its levels of labor productivity is more than 40% in 2019, secondly, Guinea was found with an increase of 22.5% this due to the protection of labor rights that they managed to reduce informality [1]. In Peru at the end of 2018, the productivity of the manufacturing sector represented 10.3% of GDP, however a 5.3% drop in the production of this sector at the beginning of 2019 affected the country's economic competitiveness [2]. This decrease

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 1069–1076, 2022.
https://doi.org/10.1007/978-3-030-85540-6_137

was due to the informality of Small and medium-sized enterprises (SMEs), and according to the Ministry of Production, informality is related to factors such as poor access to financing, low production levels and mainly low productivity of workers of work [3].

SMEs are companies that are characterized by not having the knowledge or experience in the implementation of studies or solution tools, since they are only based on their intuition [4]. Low labor productivity in a manufacturing company is a very significant problem as it affects production, generating demand defaults, order delays, loss of man-hours, among other factors that mean costs that are generated. Some studies where this problem is evident are, firstly, that of Gonzales et al. [5] evaluated the ergonomic risk conditions of 27 workers of a company that manufactures tinplate containers. This study was carried out through the REBA method, where 94% of those evaluated presented discomfort such as musculoskeletal pain, the implementation of a proposed ergonomic program reduced the risk level from very high to medium and achieved a 2% increase in productivity labor.

2 Estate of the Art

2.1 The Posture-Base Dimension in a Production Model in the Manufacturing Sector

Given the existence of different technical methods for the body evaluation of the human body, anthropometry was chosen, the study best used for the estimation of body composition measurements. The use of anthropometry as a measure of the human body is essential for the redesign of more functional workstations and mainly, that ensure the well-being of the operators in terms of their health and safety [6, 7]. In addition, other authors affirm that anthropometry impacts the sustainability of companies in the manufacturing sector by reducing the consumption of raw materials, increasing the useful life of products and achieving a positive influence on production levels. The use of anthropometric indicators for the study of body measurement presents characteristics such as its execution in a short time, therefore its implementation in a manufacturing SME to improve working conditions is the most appropriate [8, 9].

2.2 The Redesign of the Area in Production Management Models of the Manufacturing Sector

The layout of a plant is reflected within a company as the physical arrangement that seeks to promote the safety and efficiency of the flow of a process [10]. Many SMEs in the manufacturing sector have an inadequate plant distribution since they start with an improvised production process, from the machinery to be used to the space used for it. This leads to producing with an inadequate installed capacity, with downtime, unnecessary temporary warehouses and excessive transfers causing cost overruns for the company [11]. The redesign of the plant makes it possible to integrate the areas by reducing travel in short sections. The absence of this study is a problem that has an impact on increased productivity as well as on manufacturing costs [12].

2.3 The Posture-Base Dimension and Plant Redistribution in a Production Management Model in the Manufacturing Sector

The measurement of the basic postures and the redesign of the work areas allow to improve not only the productivity in a company but also influence the health and well-being of the workers. This is due to the fact that when the posture is carried out for a long time during a working day, it generates a negative impact on the health and safety of the worker, producing a lower performance in their functions [13]. In the same way it happens when there is a bad distribution in the work areas since the worker makes extra efforts when moving from one work station to another. This is why the combination of these two bad practices can harm production times and, failing that, labor productivity [14].

These studies focused on changes in the labor activity of manufacturing companies, represented an improvement in the prevention of ergonomic problems in workers and this was reflected in an increase in their productivity. [15].

3 Contribution

3.1 Proposed Model

In the model proposed at the micro level (Fig. 1), the study of posture measurements in workers was mainly proposed for a more personalized work environment and thus avoid possible injuries to their health, together a redesign of the area is proposed of work to reduce unnecessary efforts during the transfer of materials between workstations.

The design of the proposed model is made up of 4 phases, the first one where the production process was analyzed using the aforementioned tools; In phase 2, a diagnosis of the working conditions was carried out using the OWAS method, carrying out the plant layout and time study for the Labor journeys; Phase 3 consists of the implementation of the solution tools aimed at improving the working conditions of the operators using Anthropometry, Relational Table and a Time Study and finally phase 4 of opportunity for improvement where proposals were established to maintain the results obtained.

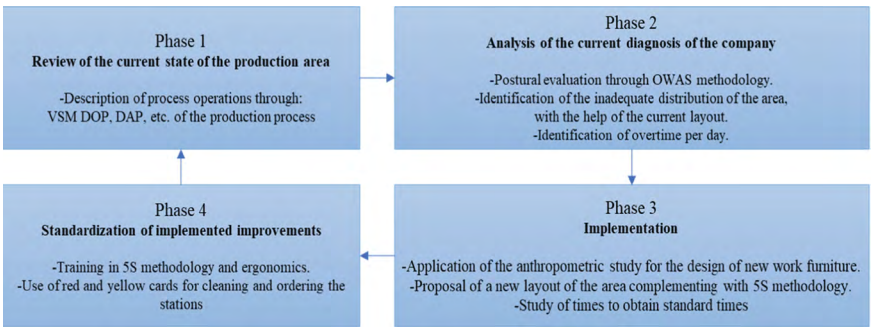


Fig. 1. Proposed micro improvement model

4 Design Validation

4.1 Initial Diagnostic

During scenario 2 (analysis), 3 problems that affected the company's labor productivity were identified: 1) The presence of ergonomic risks in 3 areas of the process where the OWAS evaluation identified the qualifications in Table 1.

Table 1. Results of ergonomic risks

Work area	OWAS rating	
Welding	2	Posture with the possibility of damaging the musculoskeletal system
Sewing		
Chopped up	3	Posture with harmful effects

2) The inadequate distribution of the work areas, in the current layout of the production area, long stretches of travel and crossings were identified that generated fatigue and fatigue in the operators, in addition to a total of 222 min of downtime due to the following factors (Table 2):

Table 2. Results of the current distribution of the plant. Source: own elaboration

Current plant layout	
Time traveled between areas	42 min
Time per arrival of the material	50 min
Time for tiredness and fatigue	25 min
Cleaning and preparation time	70 min
Time per material search	35 min

Finally, 3) Overloaded working hours, due to the increase in overtime, in this he carried out a Time Study evaluating the operators with the Westinghouse system and the Tolerance percentages, obtaining valuation factors and supplements on average of 1.11 and 25% respectively, which are very high and increase the standard times of each area.

With the standard times obtained, the VSM was performed to identify the bottleneck of the process and calculate the Taktime of the product = 1640 min/und, being less than the bottleneck (1990 min), with these data the current production was calculated in 5 und/month, the average demand being 6 units, which indicates that units are ceasing to be produced.

In scenario 3, in the first place, for the presence of ergonomic risks, an anthropometric study was carried out with measurements such as height, elbow height, popliteal height and shoulder width of the operators of the cutting and sewing areas to implement a adjustable table and chair respectively, since in both areas there are risky postures that affect operator performance (Fig. 2).

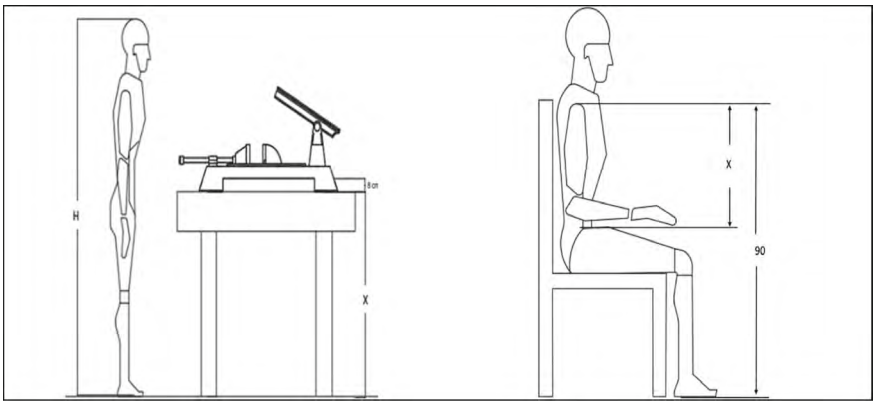


Fig. 2. Calculated posture measurements. Source: own elaboration

Second, for the inadequate distribution of the production areas, the Table and the Activity Relationship Diagram were used in order to identify which areas should be close based on the criteria of the production process as shown (Fig. 3):

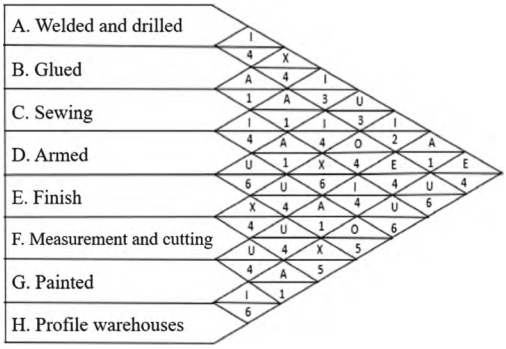


Fig. 3. Relational table for area redistribution. Source: own elaboration

With the elaboration of the distance and cost per transfer matrices, the route was improved (Table 3).

Table 3. Results of the improved plant distribution

Variables	Current distribution	Improved distribution
Travel (meters)	278	243

Finally, with the previously implemented tools, a new Time Study was carried out where an average of 1.06 and 17% was obtained as a valuation and supplement factor, which allowed the reduction of the bottleneck and standard time of the areas (Table 4).

Table 4. Results of the time study

Work areas	Current standard time	Improved standard time
Chopped up	859 min	789 min
Welding	759 min	646 min
Painted	536 min	463 min
Sewing	873 min	854 min
Armed	1990 min	1809 min
Glued	664 min	533 min
Finish	310 min	285 min

4.2 Start up

For the validation process, the Arena software was used where two scenarios will be simulated, the current situation with the previously mentioned data and the scenario of the improvement proposal where the new valuation factors and qualified supplements will be applied.

4.3 Model Detail

With the aforementioned data, the implementation of the improvement scenario was carried out, the data obtained were the following (Table 5):

Table 5. Arena results (current situation). Source: own elaboration

Variables	Current situation
Productivity (und/hH)	0,0012
Cycle time (min)	6195
Orders placed	3

It is inferred that with a productivity of 0.0012 and a production time of 6195, the company reaches 3 orders in a period of two weeks. This result is planned to increase in order to cover the productive capacity of the company in its entirety, in addition to increasing the percentage of utilization of the workers.

The data found in the execution of the second scenario are the following (Table 6):

Table 6. Arena results (improvement situation). Source: own elaboration

Variables	Improvement situation
Productivity (und/hH)	0,0016
Cycle time (min)	5511,4
Orders placed	4

These data indicate that if you get a productivity of 0.0016 and a cycle time of 5512, you can get 4 orders.

4.4 Comparison and Analysis of Results

After interpreting the results issued by the software, the following comparison was made between both scenarios (Table 7):

Table 7. Comparison of final results. Source: own elaboration

Variables	Current situation	Improvement situation
Productivity (und/hH)	0,0012	0,0016
Cycle time (min)	6195	5511,4
Orders placed	3	4

5 Conclusions

The implementation of the proposed production model achieved an increase in labor productivity from 0.0011 und/Hh to 0.0016 und/Hh, that is, an increase of 25%.

The redistribution of the plant achieved a 45% reduction in transportation costs, in addition to reducing the total distance traveled by product to 263 m, from which it was initially 279 m.

The improvement of work postures and ergonomic conditions in the area allowed the reduction of the standard time by an average of 15% used in each activity according to the Westinghouse and% tolerance evaluation.

The proposal model has a micro-level scope applied to a single manufacturing SME, that is, it can serve as a guide for specific cases where a company with the same characteristics is analyzed.

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Mathematical Model for Assessing a Single Autonomic Nervous System Index in Express Diagnostics of Thyroid Function

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Abstract. The article presents a method of mathematical computer analysis of the state of the main regulatory system of the body - the autonomic nervous system in patients with thyroid diseases. A formula has been proposed that allows one to calculate the severity of impairments in the regulatory system and the degree of stress (depletion) of adaptive mechanisms - a single vegetative index (SVI). Using the method of computer modeling, the boundary values of this indicator were determined and the effectiveness of its use was tested on a group of patients (26 people) diagnosed with thyroid diseases. The results obtained confirmed the effectiveness of using the method, both for assessing the current state of the body, and for determining the safety of the functional reserves of the body and predicting the course of the disease.

Keywords: Thyroid gland · Mathematical modeling · Autonomic nervous system

1 Introduction

Methods of mathematical modeling are increasingly used in modern medicine, especially in the express diagnosis of various pathological conditions. These methods make it possible to identify disease predictors at early stages and calculate formulas based on the available indicators obtained during the initial examination of the patient. Methods of computer analysis in medicine are suitable for the analysis of dysfunctions of the body at the level of regulatory systems and, first of all, neuroregulation. It is the autonomic nervous system that is the primary and leading link in the neuro-endocrine-immune regulation of the body's functioning. These methods are especially effective in systemic diseases, when the pathological process develops at the level of the whole organism with a violation of regulatory mechanisms. Such diseases include thyroid dysfunction, since thyroid hormones are involved in the regulation of the functioning of the cardiovascular

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 1077–1081, 2022.
https://doi.org/10.1007/978-3-030-85540-6_138

system (heart rate, blood pressure, etc.), gastrointestinal tract and excretory system, are responsible for the rate of cellular metabolism and are involved in the regulation of protein, carbohydrate and fat metabolism and perform many other functions.

The development of methods that allow quantifying dysfunctions of regulation is a promising line of research that allows one to assess not only the features and severity of the course of the disease, but also the body's response to this endogenous influence. These methods include the analysis of heart rate variability - HRV using the methods of autocorrelation and spectral analysis, based on biological cybernetics and the theory of functional systems. Heart rate variability was determined as a result of the influence of numerous regulatory mechanisms (nervous, hormonal, humoral) on the circulatory system [1, 2]. The body's resources and adaptive reserves are different for each person. Therefore, one and the same disease proceeds differently, which means that the therapeutic approaches should be different. Modern medicine preaches an individual approach to the patient, and this is impossible without assessing the features of the regulatory systems that provide this individuality in each specific case. Finding methods to estimate these parameters is always a challenge. And only the method of computer (mathematical) modeling allowed us to develop an indicator for assessing the state of regulatory systems based on the existing technology - recording an electrocardiogram with subsequent analysis of cardiointervals [3].

1.1 Purpose

To develop a quick and affordable method for assessing the autonomic nervous system (ANS) provision of the body based on the analysis of electrocardiogram indicators and to evaluate the effectiveness of its use in the early diagnosis of endocrine diseases using the clinical example of thyroid dysfunction.

2 Materials and Methods

We analyze heart rate variability using a conventional ECG by calculating cardio intervals. As a result, we obtain a chronogram in the form of a certain geometric structure, the parameters of which are then measured and used as integral characteristics of the initial chrono-cardiogram. When analyzing the resulting geometric model - a histogram, the main measurements (histogram width) are converted according to certain rules into characteristics of heart rate variability (HRV).

The analysis result is a histogram of the distribution of the recorded R-R intervals. RR interval sequences have been found to have long-term correlations. The values of the duration of the R-R intervals with a step of 0.05 s have been seen at the x-axis, the ordinate shows the number of intervals that fall into this class. The state of autonomic regulation can be understood by the shape of the histogram, in particular, the ratio of the sympathetic and parasympathetic systems of ANS. When analyzing the distribution, a number of statistical characteristics of the rhythm are determined: Mo - mode - value of the most common R-R interval. Vogue is the most frequent value of the cardio interval in this dynamic range. With a normal distribution and high stationary of the studied process, Mo differs little from the mathematical expectation (Mo). AMo - amplitude

mode - frequency of occurrence of Mo in the analyzed set of intervals (as a percentage of the total number of R-R intervals); AR-R – range - the difference between the maximum and minimum values of R-R intervals.

The heart rate variability and a single ANS index (SANSI) can be analyzed and calculated according to the formula: SANSI = AMo/2 * VR * Mo + AMo/BP + AMo/Mo, where AMo is the amplitude of the mode, Mo is the mode, and VR is the variation range. The unit of measurement was - score. When the values of the SANSI is < 150 – it means the of the thyroid gland is normally functioning, the selected therapy used for the treatment of thyroid dysfunction is adequate and when the values of the SANSI are > 150 – it means the function of the thyroid gland is reduced, hormonal replacement therapy in hypothyroidism requires correction (patent № 2324423RU, 2008y. "Method for diagnosing the degree of hypothyroidism compensation") [4].

An important condition for the study is cardio-intervalography in a patient's calm state, since all autonomic parameters are quite sensitive to an increase in the tone of the sympathetic nervous system (psycho-emotional stress, physical stress, etc.). In a healthy person, this could be attributed to the limitations of the study, however, in patients with constant tension of regulatory systems (somatic or endocrine disease) SANSI quite accurately characterizes the level of tension of adaptation mechanisms, namely, existing disorders lead to tension at the control level (SANSI < 150 points) or central regulatory mechanisms are involved (SANSI < 150).

3 Results

An examination of 26 patients with a diagnosis of hypothyroidism was carried out on the basis of the Central Clinical Hospital No. 2 in N.A. Semashko "Russian Railways (Moscow, Russia) in 2018, as part of the study approved by the Ethics Committee of the Medical Institute of the Russian University of Peoples' Friendship (protocol No. 30 of 22.02.2018). The patients were divided into three groups: 1st (11 people, mean age 48.4 $\pm$ 5.1 years) - with subclinical hypothyroidism; 2nd (6 people, average age 44.5 $\pm$ 4.7 g.) - patients with overt hypothyroidism; 3rd (9 people, average age 47.2 $\pm$ 3.4 years) - with drug-induced euthyroidism. Primarily, the functional state of the thyroid gland was determined by the method of assessing the level of hormones TSH (thyroid stimulating hormone) and fT4 (thyroxine). The study was carried out in dynamics: the first - upon admission to a hospital, repeated - after 1 month, the third study - after 3 months. A clinical examination was carried out with an assessment of complaints, objective data, heart rate, blood pressure, etc. Laboratory research have been checked, including determination of the level of hormones TSH and fT4 by the method using Automatic analyzers from Abbott, Ortho-Clinical Diagnostics. SANSI was calculated by "Method for diagnosing the degree of hypothyroidism compensation".

The results were statistically processed using the Statistica 10.0 software package. The statistical significance of the differences was established using the inversion test. Spearman's rank correlation coefficient was used to assess the degree of relationship between quantitative characteristics. Differences were considered statistically significant at $p < 0.05$. In each group, the average SANSI were calculated in all patients, and in each individual case, the data on the assessment of the functional state of the thyroid

gland according to the EVP and the level of hormones were compared. The level of correlation between the indicators obtained in the analysis of hormones and SANSI was quite high ($r = 0.81$). Complete coincidence of conclusions was noted in group 2 (TSH - 21.4 ± 1.9 μU/ml, free T4 - 4.1 pmol/L; SANSI - 174.7 ± 3.9). In groups 1 and 3, only 3 conclusions did not coincide (11% of those included in the study). Each case of mismatch was analyzed by us individually in the dynamics of prospective follow-up. In group 1 (patients with subclinical hypothyroidism) in 2 cases, when the TSH level indicated the presence of subclinical hypothyroidism, the SANSI value was 134 and 91, respectively. The dose of the received levothyroxine was not changed, and after 3 months the TSH level also reached the standard values, which confirms the formation of changes at the level of regulatory systems at an earlier stage (according to the SANSI) than changes in the parameters of hormones in the blood. In one case, a patient in group 3 (with drug-induced euthyroidism) had an SANSI level of – 166. Recommendations for increasing the dose of levothyroxine were not followed, and after a month the TSH level reached 4.9 μU/ml. This also confirms the higher sensitivity of the method for determining the SANSI for early diagnosis of hypothyroidism and effective control over the quality of therapy.

Clinical case №-1. Patient A. Diagnosis: Mild primary postoperative hypothyroidism. Regular dose of L – thyroxine is 25 μg. According to the stated formula, the SANSI was calculated, SANSI = 90. Therefore, the dose of the drug is adequate and does not need correction. The level of TSH has been checked for the confirmation - 1.8 μU/ml (N 0.24–3.4 μU/ml); fT4 - 15.1 pmol/l (N 10.0–23.2 pmol/l).

Clinical Case №-2. Patient B. Diagnosis: Autoimmune thyroiditis, atrophic form. Moderate primary hypothyroidism, decompensatory stage. The dose of the L-thyroxine was 100 μg. The SANSI was calculated, the SANSI = 240.

Consequently, the function of the gland is reduced; the dose shall be corrected. The level of TSH has been checked - 0.04 μU/ml (N 0.24–3.4 μU/ml); fT4 - 76.4 pmol/l (10.0–23.2 pmol/l). At a dose of 150 μg of L-thyroxine, the SANSI = 100, a repeated study of thyroid hormones showed TSH - 0.30 sT4 - 20.2, which indicates the sufficient dose of the L-thyroxine.

The most significant technique turned out to be for patients with euthyroidism, but receiving hormone replacement drugs (group 3), since it made it possible to predict the effectiveness of the already prescribed treatment (and, therefore, its sufficiency to achieve the planned effect). And patients with subclinical hypothyroidism (group 1) In routine clinical practice, control of the adequacy of treatment is carried out after 3 months by the level of hormones - thyroid stimulating hormone (TSH) and free thyroxine (fT4). In the study group, we calculated the expected therapeutic efficacy depending on the values of a single vegetative indicator. And compared the calculated values with the data of dynamic control for the level of hormones after 3 months.

In the first group of patients with SANSI $\geq$ 150 points (4 people), there were 3 clinical signs of hypothyroidism, which was also confirmed by the hormone level. Only 1 patient developed hypothyroidism in patients with a SANSI level $<$150 points (7 people). The relative risk of developing hypothyroidism with SANSI values $\geq$150 points was – RR = 5.25 (CI 0.78; 35.12).

In the group of patients with drug euthyroidism, there were 5 people with SANSI ≥ 150 points, and all of these patients developed clinical signs of hypothyroidism three months later. In patients with SANSI < 150 points, only one. Relative risk RR $= 4.0$ (CI 0.73; 21.84).

High SANSI values in both groups testified to a multiple increase in the risk of hypothyroidism manifestation and indicated a lack of hormone therapy. Therefore, the method allows both to predict the course of the disease and the effectiveness of therapy, and to promptly correct (or make) prescriptions to the patient.

4 Conclusion

Modern technologies using computer modeling methods greatly facilitate the process of obtaining information from biological objects and bring predictive assessment methods closer to clinical practice. Currently, to assess the function of the thyroid gland, the determination of the level of hormones (TSH, fT4, fT3) is used - a rather expensive method that requires a special laboratory and expensive reagents, therefore, studies are carried out at intervals of 1 every 6 months. To assess the effectiveness of the therapy, at least 1.5 months of treatment is required before the analysis of hormones can be used to evaluate its effectiveness. The advantage of the method is the general availability of the initial information (only ECG is needed), low cost, the ability to predict the dynamics of functional changes, treatment results and the course of the disease, non-invasiveness, high efficiency with a sufficient depth of analysis, can be used at the stage of subclinical hypothyroidism.

The proposed method can be widely used in clinical practice for operational monitoring of the effectiveness of treatment, since in this case a short-term ECG recording can be used (as opposed to daily monitoring of the heart rate, for example).

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Social Inclusion in an Aging World: Envisioning Elderly-Friendly Digital Interfaces

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Abstract. The mobile device ownership rate of the elderly is rising, but there are few suitable specific design principles. In addition, assessing an elderly-centered design's usability and social benefits is challenging, but the existing human-computer interaction does not fully support it. By making it easier to obtain digitalized life through mobile devices, the elderly can gain more benefits. This project aims to fully understand the needs of the elderly by investigating the current aging trend in China's society and the living conditions of the elderly and designing and developing a digital interface based on cognitive psychology theories that promote it to different communities and hospitals. This study produces two application concepts for the elderly on various platforms, including mobile phones, tablets, and wearable devices. In a social sense, such products can increase attention to the elderly, measure the mental health of the elderly.

Keywords: User interface · Inclusive design · Aging people

1 Introduction

Both developed and developing countries are experiencing rapid population aging. For example, the World Health Organization estimates that by 2050, China's population over 60 years old will reach 400 million. Thus, 'Ageing society' refers to a specific type of society that emerges during a demographic transition. Large shares of populations age more than 65-year-old have become a severe problem for the whole world [1]. The elderly face illness, loneliness, social isolation, dependency, and impoverishment. And

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 1082–1087, 2022.
https://doi.org/10.1007/978-3-030-85540-6_139

research has shown that they have higher recognition and friendly feelings by family members, and society will have lower suicide rates [2]. Aging relates to many biological, cognitive, and social changes that impact technology, especially mobile terminals [3]. The mobile device ownership rate of the elderly is rising, but few suitable specific design principles were designed for them. In addition, assessing an elderly-centered design's usability and social benefits is challenging, but the existing human-computer interaction does not fully support it. By making it easier to obtain digitalized life through mobile devices, the elderly can gain more benefits.

Inclusive design is a design philosophy in which the target in the whole design process is to consider every user (e.g., the elderly or the disabled [4]) needs and capabilities. Inclusive design aims to design products that are accessible and usable for the most maximum number of users and will not make the user, like aging people, feel the need for special aids and adaptions [5]. The human interface for the most digital system has been designed especially for the younger population who know technology quite well. In this way, mobile devices become more difficult for the elderly who get impairment of daily abilities. Thus, inclusive design for elderly-friendly digital interfaces can be simplified, making it easier for the elderly to better participate in the digital era, which can help them improve their quality of life [6]. As people grow old, their abilities change. There are essential characteristics that occur, including a decrease in physical, sensory, and cognitive functionality; more appearing problems with cognition, such as dementia, memory dysfunction, and the ability to learn new techniques. Generally, compared with younger people, the elderly' behavior worse in terms of vision, hearing, motor function, and cognition. For example, they have decreased visual acuity and working memory [7], loss of hearing, and reduced strength.

According to these general effects of the aging process, designers have figured out several potential design solutions, includes improve illumination, keep it simple as possible, and inclusive. This project aims to fully understand the needs of the elderly by investigating the current aging trend in China's society and the living conditions of the elderly and designing and developing a digital interface based on cognitive psychology theories that promote it to different communities and hospitals. This study produces a series of application concepts for the elderly on various platforms, including mobile phones, tablets, and wearable devices.

2 Design Process

The research follows a User-centered Design research process [8]. There are five stages of the design research process: explore, define, design, formative test, re-design. Based on second-hand research papers, reports, existing products designed for the elderly, the research team summarizes current design guidelines, preferences, cognition status, needs to create digital products. The team conducted contextual observation and interviews where the elderly join square dancing, playing cards, scan QR code, chat on WeChat. Then these research results were analyzed by groups and proposed users' needs, using scenarios and design questions. The team followed research findings, considered users' needs, and used scenarios from different target user groups, which helps to generate various design ideas. And the team designed several paper-based prototypes. Participants

were screened to join the formative testing session by providing valuable feedback and suggestions. The research team design formative testing tasks and record the whole process of interacting with prototypes [9]. Finally, the team did re-design to iterate design prototypes via Figma, an online interface design tool.

2.1 Case Study 1: Space Genius

This design case aims for the elderly to solve the design challenges they usually bumping against sharp objects and falling problems due to the decline of spatial orientation ability [10]. We would like to enable the elderly to live an everyday life through assistive portable digital products. The spatial orientation ability is weakened, which brings a lot of inconvenience to the elderly. Therefore, the elderly need to increase their spatial orientation ability with the support of others. Furthermore, due to a decline in spatial orientation, especially depth perception, the elderly have trouble perceiving the distance between objects and themselves [11]. We design a wearable device (smart glasses) to assist the elderly in spatial orientation, on the premise of not harming the self-esteem of the elderly, to provide the elderly with aids (Fig. 1).

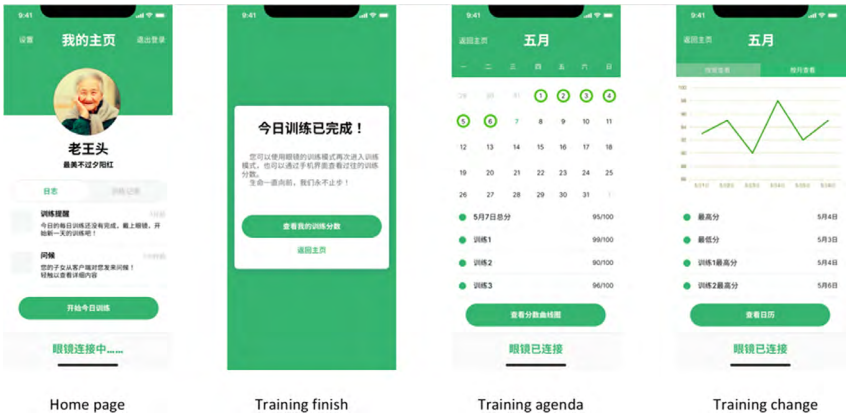


Fig. 1. User interfaces of space genius.

The core features consist of auxiliary and training. In the auxiliary part, the elderly put on the glasses we designed to provide them with additional scene information (adding color blocks to the objects). For example, when the distance between the item and the user is within a specific meter, the closer the item is, the brighter the color will be. In the training part, the elderly with glasses sort the objects on the same plane, and the colors on the objects after sorting are consistent with the colors on it, and we present for them.

2.2 Case Study 2: Medal War of Honor

This case aims to maintain the cognitive flexibility of the elderly veterans' minds and exercise their mental arithmetic skills through the game's design. Through the battle

mode of the game, elderly veterans can gain a sense of accomplishment, maintain the connection with their comrades in arms, and help improve their happiness in life. With the increase of age, the cognitive ability of the elderly gradually declines, and the decline in mental arithmetic ability and numerical sensitivity is pronounced. For Chinese elderly veterans, lack of social participation is another major problem. The study has shown that the elderly Chinese elderly male veterans had a poor social engagement. And depression, poor cognition, troubled relationships, and illiteracy were all independent predictive factors for poor social engagement [12]. Therefore, elderly veterans have vital social needs, and they also need to maintain mental flexibility and exercise daily calculation skills (Fig. 2).



Fig. 2. User interfaces of medal war of honor.

To maintain the elderly veterans' mental flexibility and meet their social needs, we will design a war strategy game that integrates mental arithmetic tasks into the familiar background of the veterans' stories. By calculating the size of the army and drawing props, they are trained in mental arithmetic and cognitive functions. Thus, the core feature is training the cognitive flexibility of veterans. Elaborately, we integrated the arithmetic task into the game, and the elderly veterans can invite their former comrades (also veterans) to join the battle game. In this way, in the game process, not only can they train their cognitive flexibility, but also enhance the feelings with former comrades in arms and meet their social needs.

3 Discussion

The elderly also has the same right to enjoy convenience from the digitalized world. They prefer interfaces with fewer elements, and direct instructions, a possible explanation for this might be that they have less previous experience about the rules, indication, and proper nouns. Therefore, designers should provide less information and based on

the existing living experience. The design system may have two terminals, the elderly terminal, and the child terminal. These findings suggest that the child pays more attention to the performance of the parents than themselves. These results are likely to be related to the meaning of quantitative evaluation that is solid evidence of training results. However, the score may reduce the internal motivations of the training [13]. This research proposed two design solutions to involve the elderly in the digitalized world and provide an opportunity to do brain exercise. There are still many unanswered questions about the effectiveness of designs and the improvements observed through fMRI [14]. This an important issue for future research to identify cognitive assistance or rehabilitation with the cognitive performance in daily life.

4 Conclusion

The main goal of the current study was to determine design solutions to fulfill the elderly's needs and provide support at any time and anywhere. From the perspective of society, such products can increase attention to the elderly, measure the mental health of the elderly, and alleviate the concerns of young people about the health of their parents, thereby promoting the stability of the whole society. This study has identified two target groups: the elderly with spatial orientation ability decline and the elderly veterans. We designed two digital applications to support them during daily life with cognitive rehabilitation guidance and vivid indications. The interface is designed for the elderly, aiming to provide equal opportunities to take advantage of the digital world.

Acknowledgments. This research is supported by the National Institute of Education and Social Development at Beijing Normal University (ID: Wa2021025).

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Patient-Specific Modelling for Preoperative Estimation of Hip Mechanics for Improved Planning of Total Hip Endoprosthesis Using Multibody Simulations

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Abstract. The increasing number of total hip arthroplasty and the demographic change lead to a rise in the number of revision surgeries. Implementation of musculoskeletal models in surgical planning could improve quality of life after revision surgery, due to the consideration of the individual patient's biomechanical conditions. In multibody simulation, a distinction is made in the degree of individualization between the anthropometric and patient-specific scaling of musculoskeletal models. In this study, the differences in moment arm length, hip joint reaction force, muscle activation and forces between these two musculoskeletal models were analyzed. Due to high influences of individualized anatomical parameters on simulation results, it is recommended to consider patient-specific biomechanics for future total hip arthroplasty planning.

Keywords: Biomechanics · Magnetic resonance imaging · Maximum isometric force · Muscle segmentation · Musculoskeletal model · OpenSim · Orthopaedics · Patient-specific modelling · Total hip arthroplasty

1 Introduction

Total hip arthroplasty (THA) is the most frequently performed joint replacement surgery [1]. Primary THA is one of the most successful and effective orthopaedic procedures to treat hip joint diseases like osteoarthritis [2, 3]. Nevertheless, surrounding muscles are exposed to direct or indirect damage in THA [4]. Direct damage occurs during the direct lateral and anterior approach to the hip joint through incision or dissection

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 1088–1096, 2022.
https://doi.org/10.1007/978-3-030-85540-6_140

of the surrounding muscle tissue e.g. gluteal muscles [4–6]. Impaired gluteal muscles may lead to higher joint contact forces and loss of function, such as hip abduction, stabilisation of pelvis and hip extension [7–9]. The human body can compensate muscle damage by increasing a surrounding muscle volume [7]. For example, the decrease in gluteus minimus (glut min) volume after THA is compensated by tensor fasciae latae hypertrophy [7].

Due to these pre-damages of the muscles and insufficient consideration of the biomechanical condition of the patient the quality of life and postoperative outcome is better with primary THA compared to revision THA [10, 11]. The most common cause of revision THA is aseptic loosening due to abrasion of hip implant [12]. High forces contribute to abrasion of the hip implant. Forces more than three times of the body weight (BW) are exerted on the hip joint while walking [8, 13, 14]. Preoperative planning should ensure an optimal force direction in relation to the activities of daily living (ADL) to minimize abrasion [15]. Musculoskeletal models (MSMs) can be used to examine the magnitude and orientation of the individual hip joint force during ADL [15, 16]. By default, MSMs are only adjusted to patient's anthropometry and weight by adjusting either the body height or by marker scaling of the subject. In a previous study, it was already recommended that individuality such as the femoral shape should be taken into account when adapting a MSM in order to obtain more accurate results for hip joint kinetics and kinematics and, thus, allow an improved planning of THA [17].

This study investigates the difference between a patient-specific and a generic scaled MSM to verify which type of MSM is more appropriate for predicting the postoperative effects of revision THA. Furthermore, this contribution presents a method for individual adaption of a MSM.

2 Material and Methods

2.1 Subject

One subject (29 years, male, 170 cm, 58 kg) with no musculoskeletal impairments of the hip area partook in this study. The participant was informed about the trial and gave a written declaration of consent.

2.2 MRI Acquisition

The MR images were acquired on a 3T Scanner (Philips Ingenia 3.0T, Hamburg, Germany) using a scanning protocol for qualitatively muscle assessment. The Volume Isotropic Turbo spin echo Acquisition (VISTA) sequence (slice thickness 3 mm, repetition time 989.9 ms, echo time 200 ms) was performed from upper iliac crest to tibial plateau split in two acquisitions.

2.3 Data Processing for Musculoskeletal Geometries and Properties

For segmentation of the musculoskeletal geometries the image processing software Mimics Research 23.0 (Materialise, Leuven, Belgium) was used. Initially, the two raw MRI

datasets were merged to allow segmentation of the entire femora. In the next step, the masks of bones and muscles were defined (Fig. 1(a)). The masks (Fig. 1(b)) were used to create 3D-models of pelvis, femur, gluteus maximus (glut max), gluteus medius (glut med) and glut min.

Due to the broad origin of the gluteal muscles, a single muscle-tendon unit would not adequately represent the entire range of action and the moment arms to the respective joint angles [18]. Thus, each segmented muscle was divided into three parts to obtain posterior, intermediate and anterior muscle-tendon units for the MSM. Therefore, two incision planes per muscle were defined. Along these planes, the respective muscle was divided into three volumes (Fig. 1(c)). To obtain the origin and insertion of each muscle-tendon unit, an averaged line was generated along the volume (Fig. 1(d)). The shortest distance from start and end point of the centerline to pelvis or femur were used to determine the muscle attachments on the bony structures. The anterior, intermediate and posterior part of each muscle is renamed into 1, 2 and 3 due to division into three volumes.

2.4 Determination of the Maximum Isometric Force

First, the individual physiological cross-sectional areas (PCSA) were calculated. The volumes of each muscle-tendon unit part were determined in the acquired MR images of the subject. Values for pennation angle θ and optimal fiber length were derived from the MSM of Delp et al. [19, 20]. PCSA is defined as (Eq. 1) [21]:

$$\text{PCSA}\,[\text{cm}^2] = \frac{\text{muscle volume}\ [\text{cm}^3] \times \cos\theta[^\circ]}{\text{optical fiber length}\ [\text{cm}]}. \tag{1}$$

Second, the maximum isometric force F_{Max} (Eq. 2) for each muscle-tendon unit of the gluteal muscles was calculated [22]. The values for the specific tension σ in mammalian muscles vary in a wide range [23–25]. A specific tension of 60 N/cm^2 was chosen as this value is within the range reported by Rajagopal et al. [26].

$$F_{Max} = \text{PCSA}\left[\text{cm}^2\right] \times \sigma\left[\frac{\text{N}}{\text{cm}^2}\right] \tag{2}$$

2.5 Scaling of the MSM

Two MSMs were generated in OpenSim 4.1 (Stanford, California, USA), one generically scaled and one patient-specific to analyse the differences. A MSM was used, which was originally developed to take into account the population data of the subjects in the modelling process [27]. The generically scaled MSM was adapted to body height and weight of the subject. The segmented 3D-structures of the pelvis and femora, body height, weight, the calculated F_{Max} as well as origin and insertion of the muscle-tendon units were implemented for patient-specific adaptation of the MSM (Fig. 1(e)). Landmarks were defined on pelvis (anterior superior iliac spine, posterior superior iliac spine, upper iliac crest, ischial tuberosity) and femora (medial and lateral femoral epicondyle) in

accordance with the recommendations of the International Society of Biomechanics in order to place them at the correct anatomical position in the MSM and to scale the limbs individually [28]. For a detailed description of the patient-specific adaptation of the MSM, refer to Scherb et al. [11].

2.6 Multibody Simulation in OpenSim

After adaption of the MSM a motion data file for single leg stance with the left leg was implemented. Actuators and ground reaction forces allowed to perform static optimization, which is used to calculate muscle activations and forces, and analyze the joint reaction forces. In addition, the transversal moment arm length of gluteal muscles during hip flexion/extension in a physiological range was computed. For the generically scaled MSM only one dataset for the results of moment arm lengths are calculated, as these are the same for the muscles of the right and left side of the body. The muscle activation, forces and moment arm lengths, and F_{Max} of the gluteal muscle-tendon units and the resulting hip joint reaction force F_R on femur of the two MSMs were analyzed.

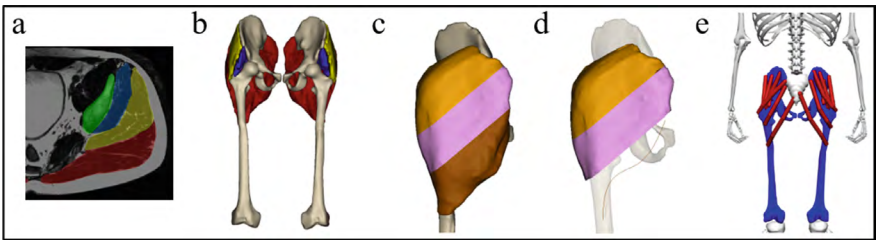


Fig. 1. Workflow of patient-specific modelling: (a) masks of segmented components (green: pelvis, red: glut max, blue: glut min, yellow: glut med); (b) anterior 3D-view of the segmented structures; (c) volumetric separation of the muscle; (d) determination of the origin and insertion of the respective muscle-tendon unit using the geometrical centerline; (e) patient-specific MSM.

3 Results

All values for F_{Max} of the muscle-tendon units are in the patient-specific greater than in the generically scaled MSM, except for glut med 1 (Table 1).

In the result description no side is specified if the value applies to the left and right side of the muscle-tendon unit. The results for percentage activation (Table 1) of the muscle-tendon units of the left leg in the patient-specific MSM are for glut max 1, glut max 2 left, glut med 2, glut med 3, glut min 2 left higher than in the generically scaled MSM. For glut max 2 right and glut max 3 the values are the same for both MSMs. The other muscle-tendon units (glut med 1, glut min 1, glut min 2 right and glut min 3) are in the patient-specific smaller than in the generically scaled MSM.

The results for occurring forces (Table 1) for glut max, glut med 2, glut med 3 right, glut min 2 left are in the patient-specific higher than in the generically scaled MSM.

The values for the other muscle-tendon units (glut med 1, glut med 3 left, glut min 1, glut min 2 right and glut min 3) are in the patient-specific smaller than in the generically scaled MSM.

F_R is 1.75 BW for patient-specific MSM and 1.26 BW for generic scaled MSM.

The transversal moment arm length for physiological hip flexion (Fig. 2) of the patient-specific MSM (left and right) is for glut max 2, glut min 2 and 3 higher than in the generically scaled MSM. For glut max 1 the moment arm of the generically scaled is larger than on the left and right side of the patient-specific MSM. In glut max 3 the three curves are between approx. 10° and 50° hip flexion very similar. In glut med 1 the left patient-specific results are higher than the generically scaled and the right patient-specific intersects the generically scaled curve at approx. 50° flexion. In glut med 2, the moment arms of the patient-specific are greater than those of the generically scaled MSM, except up to approx. 50° hip flexion. In glut med 3 the values of the patient-specific MSM are higher than in the generically scaled MSM, except up to approx. -8° flexion where the generically scaled value is higher than the patient-specific one of the left side. For glut min 1, the values of the patient-specific are higher than those of the generically scaled MSM, except at about 108° flexion.

Table 1. Results of static optimization and muscle properties

Muscle-tendon unit	Patient-specific F_{Max} [N][a]	Generic F_{Max} [N][b]	Muscle activation [%]		Muscle force [N]	
			Patient-specific[a]	Generic scaled[a]	Patient-specific[a]	Generic scaled[a]
Glut max 1	959 | 1030	573	50.5 | 4.8	4.1 | 1.0	126.4 | 19.3	15.7 | 4.4
Glut max 2	1137 | 1084	819	15.5 | 1.0	1.0 | 1.0	41.6 | 7.0	5.7 | 6.6
Glut max 3	1103 | 1122	552	1.0 | 1.0	1.0 | 1.0	6.4 | 8.4	4.0 | 4.9
Glut med 1	509 | 595	819	49.4 | 2.5	53.8 | 3.9	230.0 | 12.4	420.6 | 30.5
Glut med 2	1076 | 1196	573	83.0 | 8.9	33.5 | 3.7	617.7 | 72.7	191.7 | 21.2
Glut med 3	936 | 733	653	36.0 | 5.7	28.1 | 4.7	112.9 | 29.3	173.2 | 29.0
Glut min 1	298 | 347	270	9.0 | 1.1	19.2 | 2.0	21.7 | 3.1	51.1 | 5.4
Glut min 2	418 | 402	285	23.3 | 1.2	19.6 | 2.5	75.7 | 2.9	55.4 | 7.1
Glut min 3	471 | 363	323	8.9 | 1.0	19.2 | 2.9	20.6 | 1.9	62.0 | 9.4

a) The values are divided into left | right. These values are determined using the results of muscle segmentation and the formulas for calculating F_{Max}.
b) F_{Max} from the generically scaled MSM are shown here. The values are the same for right and left muscles.

4 Discussion

F_{Max} of the generically scaled MSM was determined similar to Hoy et al. [29] and a scaling factor was applied to correlate with F_{Max} measured on the subjects [30]. The variations in magnitude of F_{Max} occur due to different calculation methods and individual

characteristics of the subject such as muscle volume. Since F_{Max} is determined by the parameters optimal fiber length, specific tension and pennation angle, these can also affect the magnitude of F_{Max}.

Glut max and glut med are activated approx. 16 and 23% during single-leg stance [31]. There are considerable differences between the two MSMs in activation of the muscle-tendon units. This may be associated with the connection of fiber length and F_{Max} with the activation of the muscle-tendon unit. The activation depends on the occurring fiber length during motion. The closer the length is to the optimal fiber length, the greater the proportion of F_{Max} available to the muscle-tendon unit. Since the fiber lengths and F_{Max} are different, the activations could vary. A further cause could be the various locations of origin, insertion and path of the muscle-tendon units. If the attachments are located elsewhere, they could possibly accommodate more degrees of freedom.

Similarly, to the activations, the forces are also increased during high muscle activation. Strong differences appear between the two MSMs for glut max 1 and 2, as well as for glut med 1 and 2. These differences may result from adaption of origin, insertion, F_{Max} and path of the muscle-tendon unit and the implementation of the segmented bony structures.

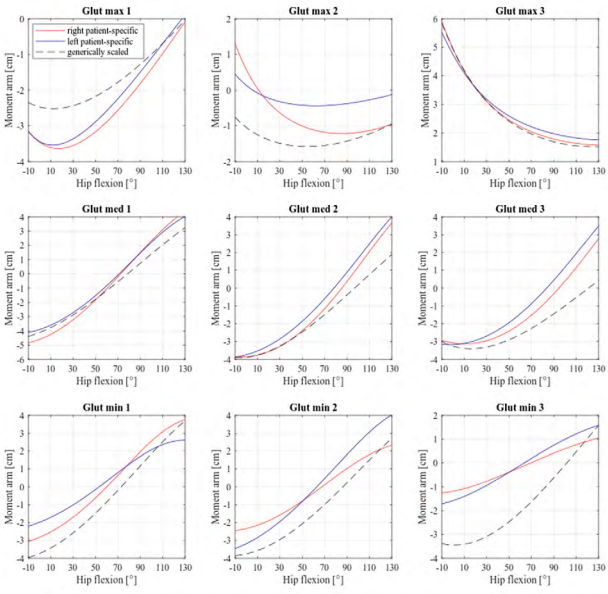


Fig. 2. Transversal moment arm lengths related to hip flexion.

F_R can reach up to approx. three times of BW in single leg stance phase of gait cycle [8, 13, 14]. Both MSMs have a lower value for F_R due to permanently standing in single leg stance. There is no acceleration of the body, which would increase F_R. Nevertheless, it can be recognised that the individual adjustment of MSM leads to a higher F_R for this subject.

The largest variations between the moment arm lengths of the generically scaled and both sides of the patient-specific MSM are mainly during physiological high hip flexion (aprox. 90–130°). These differences are due to the modification of the muscle-tendon unit origin and insertion, as well as the implementation of the patient-specific bony geometries [11]. Therefore, a patient-specific adaption would be recommended for improved planning of revision THA.

This study comprises a few limitations. Reconstruction errors of femora and proximal end of glut max may have resulted from splitting the measurement area into two MRI acquisitions. A complete registration in one acquisition was not possible due to limitation of maximum measurement length of MRI scanner by coil length (approx. 40 cm).

The major limitation is the determination of muscle attachments and some muscle parameters (e.g. tendon slack length and optimal fiber length). For example, the direct head of rectus femoris distinctly originates at the anterior inferior iliac spine [32]. However, the definition of muscles attachments of broad muscles (e.g. glut max) may be subjective as they do not originate and insert at a punctual anatomy landmark. In most trials, only the coordinates of the muscle attachments are published in relation to the respective coordinate system of the bone [33, 34]. Thus, no conclusions can be drawn about the anatomical landmarks of the muscle origin and insertion or correct separation of the muscle volume to obtain the muscle attachments. A standardised process for muscle division should be developed to ensure comparability. Moreover, the parameters F_{Max}, origin and insertion of the muscle-tendon unit depend on this process and would affect the results of the multibody simulation.

5 Conclusion

Differences between the generical and the patient-specific MSM appear for all analyzed parameters. Hence, it is recommended to continue research in this topic for optimal planning of revision THA, better quality of life and postoperative outcomes for the patient after revision surgery. In this study only one subject was examined. In the future, a larger patient sample should be included in order to achieve more representative results. Further studies should include other biomechanical parameters and motions e.g. walking to obtain reliable results for ADL, as well as other generalized hip coordinates, especially the moment arm length during hip abduction.

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Application of the Human Thermo-Physiology in the Assessment of Comfort Conditions in Hybrid Buildings

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Abstract. This article presents a numerical work on the occupants' comfort conditions of a building where passive and active solutions have been implemented. The comfort conditions are evaluated using a software based on the human thermo-physiology, used to simulate the human thermal and thermoregulatory and clothing thermal response. The building has constructive characteristics that allow it to use solar radiation as a passive solution. As an active solution, it is proposed to operate the Heating, Ventilation and Air Conditioning system through the control of the occupants' thermal comfort level. The whole building thermal response in transient conditions is obtained by a research software. The indoor thermal comfort and the indoor air quality were obtained for all occupied spaces. The implemented control system uses the Predicted Mean Vote index as a control variable. The obtained results show that the adopted solutions allow to improve the thermal comfort level of the occupants.

Keywords: Solar radiation · HVAC system · Thermal comfort · Indoor air quality · PMV control · University building

1 Introduction

In this work, the Building Dynamic Response (BDR) numerical model used to simulate the implementation of the Heating, Ventilating and Air-Conditioning (HVAC) system controlled taking into account the human thermo-physiology is applied.

The BDR numerical model, that evaluates the building and internal environmental variables, works with the Human Thermal Response (HTR) numerical model, used to evaluate the human thermal comfort level, and the Computational Fluid Dynamics (CFD) numerical model, used to evaluate the internal environments variables. Examples of the application simultaneously of these numerical models are shown in Conceição and Lúcio [1, 2] and Conceição et al. [3].

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 1097–1104, 2022.
https://doi.org/10.1007/978-3-030-85540-6_141

BDR simulates the building thermal behavior response and calculates numerically the internal temperature and surrounding virtual compartment surfaces temperatures, which details are shown in Conceição and Lúcio [4]. The application of this software can be found in the studies of Conceição et al. [5], and Conceição and Lúcio [6–8]. HTR numerical model, that simulates the human thermo-physiology and evaluates the human thermal comfort, the tissue and clothing temperatures, can be seen, for more details, in Conceição et al. [4]. Applications of this numerical model can be analyzed, for example, in Conceição et al. [9–11]. Regarding to the CFD, which is used to evaluate the airflow inside the spaces and inside the ducts, more details are presented in Conceição et al. [12].

The thermal comfort level, using the Predicted Mean Vote (PMV) and /or the Predicted Percentage of Dissatisfied people (PPD) indexes, was developed by Fanger [13], and it is presented in ISO 7730 [14]. For example, these indexes were applied, using numerical models, in the control of a HVAC system by the PMV index [15], in the temperature control of a HVAC system [16], and in the evaluation of a school building with the use of an adaptive thermal comfort model [17]. Their application in the conduction of experimental studies can be seen in Conceição et al. [18].

Limits of airflow rate and carbon dioxide (CO_2) concentration, used as indicator of the indoor air quality (IAQ) in occupied spaces, can be found in ASHRAE 62.1 [19]. This indicator was applied using the BDR software, for example, in the numerical studies of Conceição et al. [20–22].

The objective of this study is to evaluate the influence of a HVAC system, without and with a control system based on the PMV index [15], on the thermal comfort of occupants and the IAQ of a real University building. In particular, its influence on the thermal behavior of rooms facing south and north will be analyzed. This study was carried out considering the whole building and its thermal response for a typical winter day season.

2 Models and Materials

The research software BDR, developed by the authors and applied in this study, is based on a system of balance integral equations of energy and mass and works in transient conditions. The energy balance integral equations are developed for the air and for the different transparent (windows), interior (doors, walls) and opaque bodies (envelope, roof) of the building. Several layers are considered for the opaque surfaces. Instead, only one layer is considered for the transparent surfaces. The mass balance integral equations, for the water vapor and for the air contaminants, are developed for the interior spaces. The Runge–Kutta–Felberg method with error control is used in the resolution of the energy and mass equations system. The equations system, used in the numerical model, is developed through a virtual building using a Computer-Aided Design software.

The numerical study was made in a University building, located in southern Portugal, mainly consisting of classrooms, laboratories, offices and other spaces. This building has passive characteristics that allow it to take advantage of solar radiation in winter conditions, such as some windows facing south. The simulation was done considering a winter typical season day. The building (Fig. 1), distributed by four floors, has 319

interior compartments, 329 transparent surfaces (windows) and 3585 opaque surfaces. The compartment occupation cycle comprises periods of 90 min, interspersed with 15-min break periods. The building is open between 8 am and 8 pm. When compartments are occupied, people have an activity level of 1.2 met [14], with an average level of clothing insulation of 1.0 clo [14], characteristic of a winter day. The airflow rate in occupied spaces is calculated as proposed in international standards [19], while in non-occupied spaces is calculated according to experimental data [23].

The simulation of the entire building was done for a period of six days, considering the last day for the analysis of the results obtained. Bearing in mind that the intention is to analyze the thermal behavior of rooms facing south and north, rooms 289 (facing south) and 304 (facing north) were chosen as representative of the results obtained. The simulations were done for two situations: without and with control of the HVAC system. The control of the HVAC system was carried out using the PMV index with the aim of maintaining an acceptable occupants' comfort level at least according to category C ($-0.7 \leq \text{PMV} \leq +0.7$) of ISO 7730 [14]. Thus, the control system acts whenever the $\text{PMV} < -0.7$ [15].

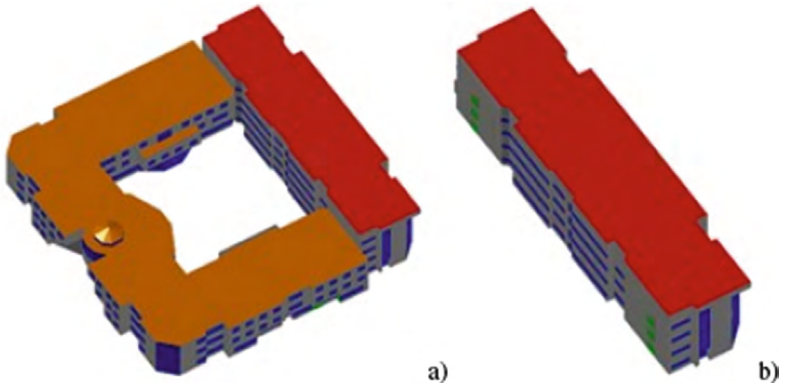


Fig. 1. University building studied: a) southeast view of the whole building; b) section of the building where the evaluated rooms are located.

3 Results and Discussion

This section presents the results obtained from the CO_2 concentration (Fig. 2), the indoor air temperature (Fig. 3), the mean radiant temperature (MRT) (Fig. 4) and the PMV index (Fig. 5) for situations without control of the HVAC system and with an HVAC system controllable by the PMV index. Figure 6 shows the consumption of thermal energy accumulated throughout the day in the rooms (289 and 304) analyzed in this study. The CO_2 concentration and the PMV index will be used to evaluate, respectively, the IAQ and the thermal comfort of the occupants.

The results show that the carbon dioxide concentration remains below 1800 mg/m^3 in all rooms analyzed regardless of the use or not of the HVAC system, thus ensuring an acceptable IAQ [19].

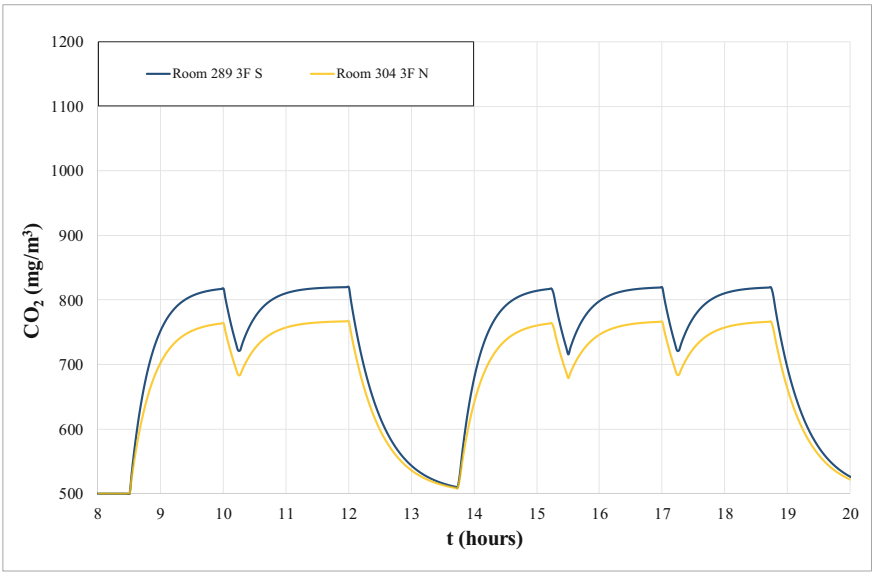


Fig. 2. Evolution of CO_2 concentration in rooms facing south (S), 289, and north (N), 304, where 3F represents their location on the third floor.

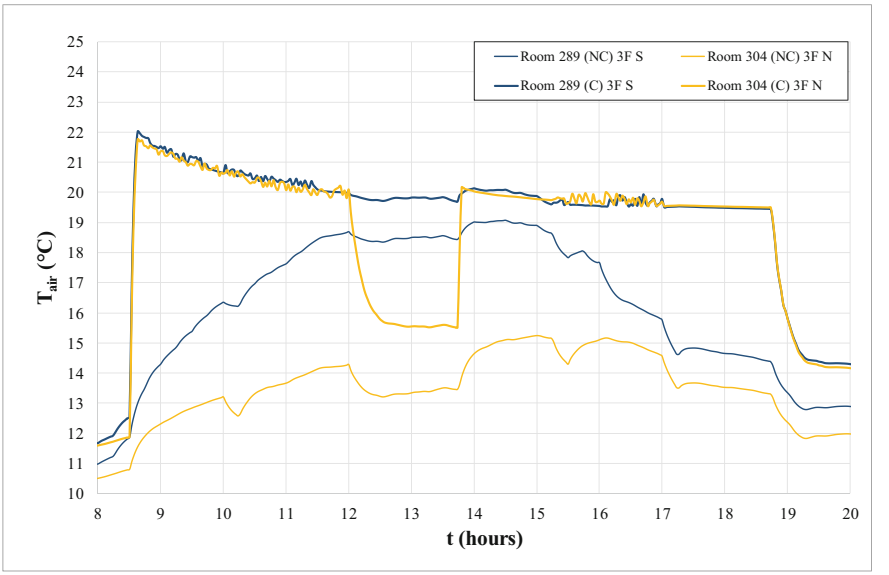


Fig. 3. Evolution of air temperature (T_{air}) in rooms facing south (S), 289, and north (N), 304, where 3F represents their location on the third floor. In the legend, NC and C represent, respectively, no control and control of the HVAC system.

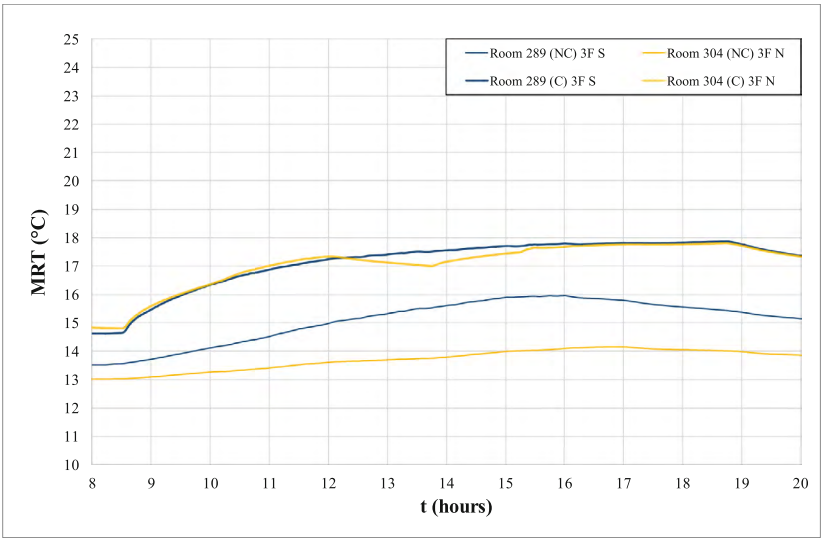


Fig. 4. Evolution of MRT in rooms facing south (S), 289, and north (N), 304, where 3F represents their location on the third floor. In the legend, NC and C represent, respectively, no control and control of the HVAC system.

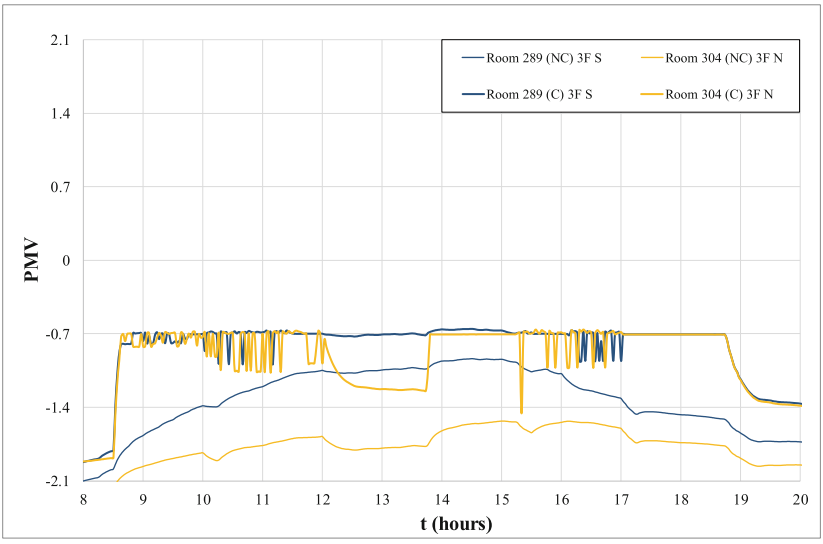


Fig. 5. Evolution of PMV index in rooms facing south (S), 289, and north (N), 304, where 3F represents their location on the third floor. In the legend, NC and C represent, respectively, no control and control of the HVAC system.

Without HVAC control, the indoor air temperature varies between about 12 °C and about 19 °C in the south-facing room, while in the north-facing rooms the indoor air

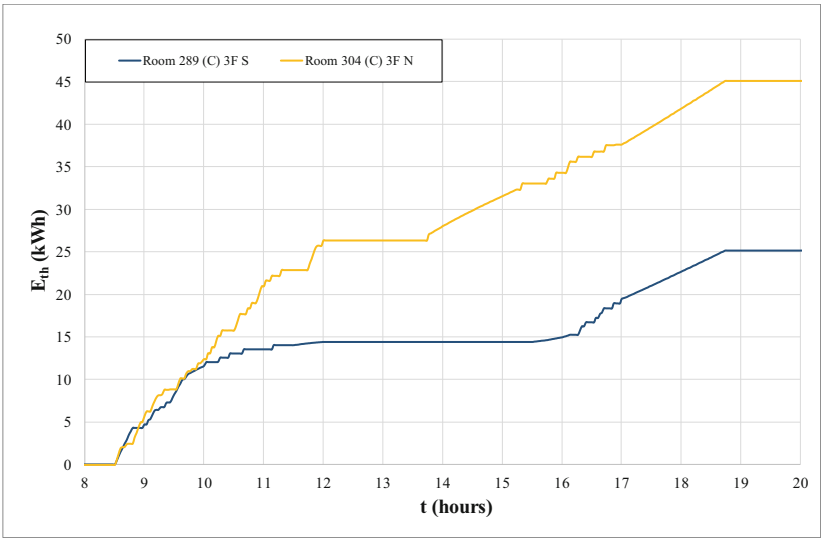


Fig. 6. Evolution of the accumulated consumption of thermal energy (E_{th}) in rooms facing south (S), 289, and north (N), 304, where 3F represents their location on the third floor. In the legend, C represents control of the HVAC system.

temperature varies between about 11 °C and about 15 °C. The highest value of air temperature is obtained around 2 pm. These results show the positive effect of solar radiation entering the south-facing room, which contributes to the increase in indoor air temperature. With HVAC control, the indoor air temperature increases in relation to the situation without HVAC system control, remaining with slight variations during the period of occupancy in the rooms shown. During this period, the temperature of the indoor air in both rooms varies between 19.5 °C in the late afternoon and 22 °C in the early morning. Without HVAC system control, MRT ranges from around 13.5 °C in the early morning to around 16 °C in mid-afternoon for room 289, and ranges from around 13 °C in the early morning to around 14 °C in the late afternoon for room 304. With HVAC system control, MRT rise in relation to the previous case, varying between around 14.5 °C in the early morning and 18 °C in the late afternoon. In this case, there are no significant differences between the MRT of the analyzed rooms.

Without HVAC control, the thermal comfort of the occupants in both rooms is not acceptable due to negative values of the PMV index. When using the HVAC system control, it is verified that the PMV index remains stable and equal to −0.7 during the occupation period, meaning that the control system is operating as expected. In this case, the thermal comfort level of the occupants is acceptable, by negative values of the PMV index, within category C [14].

The highest value of the daily consumption of thermal energy, 45 kWh, was obtained in the north-facing room. In south-facing room, the daily consumption of thermal energy is around 25 kWh. This significant difference is justified by the exposure to incoming solar radiation from the south-facing room, thus requiring less thermal energy from the HVAC system to promote its heating.

4 Conclusions

In this work, it was applied the human thermo-physiology analysis in the assessment of comfort conditions of a real University building. In this sense, the influence of a HVAC system, without and with a control system based on the PMV index, on the thermal comfort of occupants and the IAQ was evaluated, particularly, for rooms facing south and north. The work was done for a typical winter day in the region, also analyzing the effect of solar radiation on the thermal behavior of the building.

According to the mainly results, it was found that the HVAC system promotes acceptable IAQ [19]. The use of the HVAC system with control allows to guarantee acceptable levels of thermal comfort for the occupants by negative values of the PMV index within category C [14]. Comparatively, the south-facing room requires less heat energy than the north-facing room. This lower heat consumption by the HVAC system reveals the contribution that incoming solar radiation promotes in the heating of south-facing rooms in the region where the building is located.

Acknowledgments. The authors would like to acknowledge to the project (SAICT-ALG/39586/2018) from Algarve Regional Operational Program (CRESC Algarve 2020), under the PORTUGAL 2020 Partnership Agreement, through the European Regional Development Fund (ERDF) and the National Science and Technology Foundation (FCT).

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Robotic Systems on the Frontline Against the Pandemic

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Abstract. Robotic systems have been effectively used in healthcare while a new role for them has emerged during the COVID-19 pandemic. Robots were used as part of prevention, screening and diagnosis of the disease, but also to assist with the treatment of patients. The purpose of the paper is to provide an overview of the relevant applications for robots and highlight their potential.

Keywords: Sterilization/Disinfection robots · Nursing robots · Service robotics

1 Introduction

Applications of robotics in healthcare are rapidly increasing with the International Federation of Robots (IFR) forecasting a growing demand for robots in the healthcare sector, estimated at 9.1 billion USD by 2022 [1]. Robots in clinical practice also include surgical systems [2] and nursing robotics [3]. Following the novel coronavirus crisis (COVID-19) a new role for robotics has emerged towards the combat of a pandemic.

Among the successful implementations are included autonomous robotic solutions employed in hospitals for disinfection using ultraviolet (UV) lights or using fog/mist disinfectants. As part of screening programs, robots were employed for temperature measurements. They may also facilitate samples collection while minimizing physical contact. Laboratory testing often involves robots for the processing of samples. As part of patient treatment, nursing robots can assist with delivery tasks within a hospital (medicine, food trays, contaminated waste etc.), effectively reducing physical contact and exposure to diseases. Different roles for mobile robots include supervision of social distancing in public areas and issuing of reminders when required. Their use may also be extended to the policing of quarantine areas.

A considerable number of relevant robotic systems has recently been developed and commercialized, which is indicative of the quick response of the robotics community to the pandemic. Universities developed prototypes to investigate different concepts but

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 1105–1112, 2022.
https://doi.org/10.1007/978-3-030-85540-6_142

companies were quick to exploit the generated market potential and business opportunities. A collection of relevant robotic systems is shown in Table 1, which is not exhaustive but is representative of the field and provides a basis for reviewing the relevant developments. Websites that are referenced were accessed at the time of publication.

The paper is organized as follows. Section 2 focuses on the preventive roles of robotic systems, i.e., sterilization/disinfection applications. Section 3 presents their screening and diagnosis role, while Sect. 4 focuses on telemedicine and nursing robots. The final section presents the conclusions and directions for further developments.

2 Prevention – Sterilization/Disinfection Robots

Disinfection and sterilization of common areas, rooms, corridors, laboratories and clinical areas is a preventive step against the spreading of infectious diseases. Current cleaning practices and procedures in hospital settings is based on human resources and in many cases, it proves ineffective, cumbersome, time consuming and costly. The use of robotics in the disinfection process has been increasing rapidly. They are suitable for large-scale deployments in healthcare facilities [4] and they typically comprise a mobile platform mounted with appropriate disinfection equipment.

Systems are divided into two categories on the basis of the implemented disinfection method: (a) disinfection using C-band ultraviolet lights (UVC); (b) disinfection using fog/mist disinfectants. On the basis of autonomy levels, systems can be: (a) remotely-controlled; (b) semi-autonomous; (c) autonomous. The last one is particularly challenging given that robots are required to operate in a dynamic, populated environment with expensive equipment. Autonomous functions for the mobile platform may include collision avoidance systems, autonomous charging, mapping and localization. Note that autonomy may refer to the motion of the robot and/or the sterilization process.

The most suitable disinfection method for a given case depends both on the application and the environment [5]. In general, UVC-based procedures are more effective when employed in settings with various types of surfaces such as tables, beds, walls and floors. As UV radiation may cause damage to organic tissue (skin burns and skin cancer), its use is not recommended in human-populated areas and fogging-based disinfection methods are more suitable. Moreover, exposure of the eyes to UV light can produce serious vision impairments. The effectiveness of germicidal UV disinfection depends on direct UV light exposure and duration. For the above reasons, a robot constitutes a suitable agent for effective and safe, large-scale implementations. Compared to fixed systems (mounted or portable) with a limited coverage, the use of robotics may enhance the effectiveness, flexibility and safety of the disinfection process.

Relevant systems which have been developed for UV disinfection, they typically consist of a mobile robotic platform on which is installed an array of ultraviolet lamps (e.g., [6–10]). The mobile platform is often equipped with sensors for collision prevention. The lamps arrangement is such that shadowing is avoided and coverage is maximized. One example is the Helios® System shown in Fig. 1a, which uses multiple light-emitting robots (a trio) in a single cycle of disinfection, to improve efficiency and reduce time [9]. Another commercial example shown in Fig. 1b, is the LumniCleanse UV-C (OMRON) robot. It is a wireless, remotely-operated, autonomous disinfection robot integrated with 16 UVC-emitting lamps. Its batteries allow for up to 3 h of operation [10].

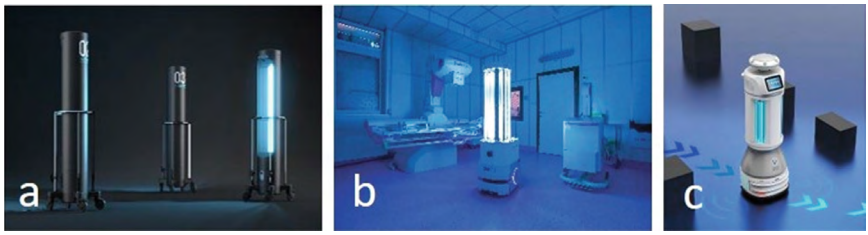


Fig. 1. Robots used in disinfection. (a) Surfacide Helios® System (photo courtesy of Surficide); (b) LumniCleanse UV-C robot (photo courtesy of Lumnicleanse Ltd); (c) Keenon Robot (photo courtesy of Keenon Robotics)

To increase their usefulness some disinfection robots are installed with extra functions, as for example the autonomous system in [11], which is also equipped with a human body temperature camera. Systems can often be operated in different control modes, as for example the disinfection robot [12], which can be operated autonomously, semi-autonomously (staff is required to open doors), or manually via a wired controller. It can be used as a single device or in a connected fleet. Safety laser scanners at the front and rear of the robot allow it to detect obstacles and people when in transit. Systems may also be endowed with advanced robot control capabilities, as for example in the case of the UVD Robot® [13]. The system does environment scanning using LiDAR technology and creates a digital map. It then relies on Simultaneous Localization and Mapping (SLAM) to navigate and operate autonomously. Its operation is suspended when the presence of a person is detected. It can also be driven manually from a distance, while the operator uses the onboard cameras to navigate via a tablet.

The next category of disinfection robots uses fog/mist disinfectants. A comparative evaluation of the operating room cleaning using an ultraviolet light method versus a manual chemical disinfection can be found in [14]. An example of such a robot is [15], which uses an atomizing or fogging system to coat surfaces, while operated wirelessly from outside a hospital room. In the case of [16], the disinfection process is monitored by integrated sensors, is registered and reports are generated. A unique case is [17], which comprises a wheeled robot installed with a 6 degree-of-freedom arm manipulating an electrostatic charged sprayer for chemical disinfection. This arrangement provides access to difficult-to-reach locations. Robot navigation is semi-autonomous, while the arm is wirelessly controlled manually. The system may be endowed with intelligence not only with regard to the mobile platform but also the disinfection subsystem itself, as in the case of [18]. A camera system coupled with an intelligent vision algorithm allows the operator to remotely locate affected areas. A distinct example that combines two disinfection methods for increased efficiency [19], is the Keenon robot shown in Fig. 1c. It is installed with a UV sterilization module and a spray disinfection module. Beyond an intelligent obstacle avoidance system, it also has a fully autonomous positioning and navigation system suitable for complex environments. Moreover, a multirobot configuration can be implemented. Another system that combines multiple disinfection methods is [20]. It moves autonomously using a map of the facilities. It integrates three disinfection modes: ultraviolet, ultra-dry vaporized hydrogen peroxide, and air filtration.

3 Screening and Diagnosis Robots

Early and timely detection of infected individuals is crucial for the effective management of infectious diseases. Telemedicine provides methods and techniques enabling doctors and patients to communicate without coming into physical contact [21]. Respiratory symptoms and high body temperature are early signs of COVID-19 infection.

Body temperature monitoring systems using robots are well-suited to highly crowded public places such as airports, schools and subway stations. An implementation example for temperature measurement is the case of [22]. Thermal sensors and relevant vision algorithms have been integrated into autonomous or remotely-operated robots to improve screening efficiency. The Misty II robot (shown in Fig. 2) is a small-size screening system equipped with a thermal imaging camera and is supported by an application [23]. It has built-in face detection and face recognition capabilities. The screening procedure also involves some interactive questions. Configurable SMS, email notifications, as well as web-based administration and reporting are available.

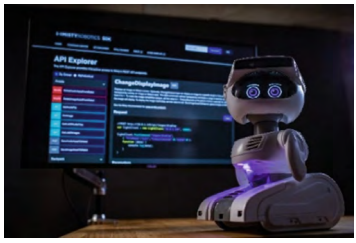


Fig. 2. Misty II screening robot (Photo courtesy of Misty Robotics)

Commercial robot models by UBTECH [24, 25] were employed as UVC disinfection solutions, for performing temperature checks for visitors, as well as interactively asking health questions while entering the facilities. They were also used to check people in public areas if they wear face masks correctly. Using their ability to navigate autonomously they were also used in performing crowd density monitoring and issuing of reminders to implement social distancing. A different temperature screening system suitable for outdoor environments is presented in [26] and allows two modes of operation. One is for drivers and passengers of mobile vehicles and the other is for pedestrians. Capability for additional measurements was included on a robotic platform teleoperated by trained clinical stuff, for remotely obtaining vital signs associated to COVID-19 patients evaluation [27]. Measurements include skin temperature, respiratory rate, heart rate, and blood oxygen saturation.

The use of robots in automatic swab sample process has also been considered, as in [28]. This robot is capable of carefully collecting the swab from the correct point in the throat, using computer vision algorithms. The sample is prepared and appropriately labelled before is sent for laboratory analysis. A different robot for swab sampling while reducing the risk of cross-infection involves a snake-like arm and an endoscope for image guidance [29]. In the same category is a low-cost miniature robot for nasopharyngeal swap sampling, which was presented in [30]. It consists of a 6-DOF passive arm for

Table 1. Robotic systems deployed against the COVID-19 pandemic.

No	Name	Company-Institution	Purpose	Ref.
1.	LightStrike	Xenex, USA	Disinfection	[6]
2.	E300	Purplesun, USA	Disinfection	[7]
3.	LASKA & Yezhik UVD Robots	Aitheon, USA	Disinfection	[8]
4.	Helios UV-C	Surfacide, USA	Disinfection	[9]
5.	LumniCleanse UV-C	LumniCleanse, UK	Disinfection	[10]
6.	ARIS-K2	Youibot Robotics Co., Ltd.	Disinfection Screening	[11]
7.	Mini^{TM} UVC	BlueBotics & Engmotion, Switzerland	Disinfection	[12]
8.	UVD Robot	UVD Robotics, Denmark	Disinfection	[13]
9.	Nimbus	Nevoa, USA	Disinfection	[15]
10.	DeconX	Decon-X, Norway	Disinfection	[16]
11.	XDBOT	NTU, Singapore	Disinfection	[17]
12.	Disinfection Robot	SIEMENS & AUCMA	Disinfection	[18]
13.	Keenon Robot	Keenon Robotics, China	Disinfection	[19]
14.	Tmi Robot	TMIRob, China	Disinfection	[20]
15.	Misty II Robot	Misty Robotics	Screening	[23]
16.	CRUZR	UBTECH, China	Screening	[24]
17.	AIMBOT	UBTECH, China	Screening	[25]
18.	SHUYU Robot	Tsingke+ Robot Joint Research Institute Co., Ltd, China	Screening	[26]
19.	Dr. Spot	Boston Dynamics	Screening	[27]
20.	Careebo LLR S1	Lifeline Robotics, Denmark	Screening-Diagnosis	[28]
21.	OP-Swab Robot	Guangzhou Institute of Respiratory Health, China	Screening-Diagnosis	[29]
22.	Swab Sampling	Wang et al.	Screening	[30]
23.	Flowbot ONE	Flow Robotics, Denmark	Screening - Laboratory	[31]
24.	Ultrasound Robot	Tsinghua University, China	Screening- Diagnosis	[35]
25.	Moxi	Diligent Robotics, USA	Nursing	[37]
26.	TRINA	Duke University's School of Engineering and School of Nursing	Nursing	[36]

global positioning and a 2-DOF end-effector for the actual sampling. The role of robotics also extents to the laboratory testing of collected samples, as in the case of a pipetting, liquid-handling robot that is used to make the process more efficient and faster, while minimizing the possibility of errors and the risk of infection [31].

4 Telemedicine and Nursing Robots

The recent pandemic caused an enormous burden on healthcare systems, while healthcare professionals are themselves highly exposed to the disease. Telehealth has been enlisted as an effective method that allows patients having COVID-19 symptoms to be examined and monitored [32]. The use of teleoperated robots capable of performing ultrasound examinations from a distance [33] may effectively help in diagnosis and health monitoring, while preventing cross-contamination. A telerobotic ultrasound system was considered for cardiopulmonary assessment of COVID-19 patients in [34]. Also, Akbari et al. [35] presented the case of US probe manipulation by a dexterous robot arm, effectively minimizing the contact between healthcare professionals and patients.

The use of nursing robots [3] has been attracting renewed attention towards reducing physical contact between healthcare professionals and patients [36]. They may also help to reduce the usage of personal protective equipment and also avoid contamination during its removal. Robots may undertake different roles including distribution of medication and food, patient monitoring, and support with patient ambulation. From a psychological perspective, robots may help provide patients with the means to remain socially connected when hospital visits are not permitted.

A commercial system called Moxi (Diligent Robotics) belongs to the above family of robots and is marketed for running patient supplies, delivering lab samples, bringing items from central supply, and delivering medications [37]. Another representative system is TRINA, which consists of a mobile manipulator robot and a human operator's console. It provides assistance to medical staff to perform routine tasks, such as carrying food and medicine, cleaning, and monitoring vital signs while at the same time communicating with the patient [36].

5 Conclusions

Robotic solutions were successfully deployed in response to the COVID-19 pandemic with applications ranging from prevention, screening and diagnosis, as well as assistance with patients' treatment. These implementations are expected to nurture further research and development in the field. The robotics technology itself has to adapt to the application needs with robots becoming more intelligent, user friendly and safe. Integration of the robotics technology and the application-specific equipment (e.g., sterilization lights) may yield more effective, safe and cost-effective solutions. The full potential of nursing robotics and robot deployments towards the prevention and management of infectious diseases is yet to be exploited.

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Effects of 3D-Printed Changeable Midsole Design in Functional Footwear

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Abstract. The 3-Dimensional (3D) printing in footwear has become a significate development direction. Researchers have found that providing a suitable insole can combat pain and help to avoid fall-related injuries. Therefore, many research projects focusing on insole designs and functionality were conducted. In contrast, a midsole design for footwear has not been adequately developed in functional footwear. A lot of footwear research projects looked at insole or midsole modification but did not include a changeable drop-in sole inside the midsole. Different softness and construction of 3D-printed midsole were developed to simulate the foot comfort and biomechanics measurement. The changeable 3D-printed midsoles can increase comfort and flexibility for customization in functional footwear. The current study demonstrates functionality and flexibility simultaneously for footwear design in terms of comfort control. Footwear consisting of different 3D-printed midsole structures that improve comfort can decrease injury frequency. Consequently, the midsole providing a comfortable, soft, and movable dual-density footbed is critical to wearers.

Keywords: 3D printing · Functional footwear · Changeable drop-in midsole · Comfort · Biomechanical

1 Introduction

Jacques and Guimaraes [1] stated that global production of footwear products has raised from 2.5 billion pairs/year in 1950 to 20 billion pairs in 2010. From the Fashionista online [2] website point out that, the sneaker industry has seen stunning growth over the last five years especially for the millennials customer. Furthermore, Goonetilleke and Luximon [3] point out that growth customization; more consumers have increased their ability to fulfill their own product needs. In addition, a lot of athletic footwear brands that evidence the 3-Dimensional (3D) technology to bring a new product and platform to life. It is shown that the potential to investigate into footwear category and significate

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 1113–1120, 2022.
https://doi.org/10.1007/978-3-030-85540-6_143

of the evolution of technology. Adidas also stated in the "Futurecraft" project 2018 [4] that it hopes to use 3D printing technology to produce custom, on-the-spot footwear for customers in the future [5].

Adidas and Nike were pioneers concerning mass customization in the sports fashion and footwear area (Baena Graciá, V., and Winkelhues, K.: 2016). Kolarik (1995) [6] stated how the factory process could be adopted for customized footwear unless the manufacturer is willing to go through several iterations to achieve a satisfactory product. Studies of customization and functional performance proved the importance.

Functional footwear manufacturers or designers are continually finding new ways to make it more comfortable, flexible and to reduce foot fatigue. Goonetilleke [7] states that a functional performance characterization refers to the different aspects of the user-footwear biomechanical interaction (fitting, pressure distribution, shock absorption) and a prediction of users' perception comfort when wearing such products. It will consider the application of functional, quality and technology. *Functional* footwear used to minimize risk of injury could be obtained from the comparison of ground reaction force in running among different sole materials components. The combination that results in minimal ground reaction force will be concluded as effective in minimizing the risk of injury. *Quality* concerns materials and construction offering major support. *Technology* is feature that can affect its function, such as minimal risk of injury and changeable 3D-printed drop-in midsole adopt the latest 3D printing technologies to reduce foot fatigue.

By referring to Baena Gracia and Winkelhues [6] the intention is that people would be able to determine the fit, function and style of their shoes. The theory about adaptive customization is that a customer adapts a standardized product to fit his or her needs. Cosmetic customization also refers to a standardized product customized in the aesthetic aspect.

3D printing technology involved with different construction is used to produce 3D-printed drop-in midsole in different shapes, softness and materials. Design changeable components which is 3D-printed drop-in midsole with the use of properties to lock the 3D-midsole in a right position. Changeable 3D-printed drop-in midsole that readily changes to customize the preference of the user without the use of adhesives or stitching. Furthermore, the latest technologies are adopted to reduce foot fatigue and to minimize the risk of injury.

2 Methodology

The project started with literature reviews, design research and product analysis. The visual aesthetic and trendy style were significant design required for prototype. This research was a mixed study that integrated both qualitative and quantitative studies. There were two phrases of data and questionnaires collection.

First, a footwear scanner was used to collect subjects' footwear data; a questionnaire was designed to collect subjects information and preference. Quantitative data analysis by using footwear scanner system which showed the measurements of feet, difference of subjects and special findings after the data collection.

Second, a set of experiments on different materials for 3D-midsole, the 3D-printed midsole shape and softness were conducted to examine the 3D-printed midsole performance, to investigate detectable mechanism, and to design the shape of the footwear by the consultant through producing the prototypes. Ground reaction force differences among sole materials were examined by force plate at specific running protocol [13].

After the prototypes were completed, subjects should complete the second phrase data collection and questionnaire. Subjects should comment on the innovative technology adopted, the functions and the comfortability after their trials. Data analysis was conducted. The functional footwear requirements include: (1) a mismatch between evolved structure and function [8] of the foot, (2) design features of modern footwear could explain the high injury rate. Finally, the conclusion and recommendation to the project and further development in the future will be discussed.

The sample comes from 30 female subjects, with the following average characteristics: (1) age: 18–38, (2) height: 155–178 cm, (3) weight: 40–58 kg, (4) foot size: 37–38 UK footwear size. All the subjects had experience in wearing sneaker for least a year.

In the first phrase survey, 10 suitable subjects were selected as case studies such that an accurate analysis of sole measurement was allowed. Foot measurement data was collected from footwear scanner data. Eighteen points of foot measurements data was collected and the data was analyzed for designing 3D-printed midsole for drop-in midsole with different softness. The different structures of changeable 3D-printed midsole were 3D printed. These changeable 3D-printed midsoles of different softness were designed for different parts such as forefoot and heel areas. The data that collected by questionnaire survey was analyzed with descriptive statistic and factor analysis by SPSS.

In the second phrase survey, the newly designed experimental prototype were tried by the 10 subjects so that their comment on its comfort, fit and detachable 3D-printed midsole was collected and analyzed. Biomechanically analysis such as ground reaction force measurement between different sole components was examined by force plate at specific walking protocol. One way ANOVA was used to analyze the differences in ground reaction force among components of sole.

A quantitative research approach was adopted by distributed questionnaires and analyzed the collected data. The performance, comfort rating and aesthetic appearance of the 3D-printed midsole technology in addition to the comments in the questionnaires undergo analysis. Comfort assessment was conducted by using a visual analog scale (VAS) to assess footwear comfort. VAS has been proven as a reliable measure to assess subjective pain. For the comfort assessment, four different conditions were adopted for testing walking with different changeable 3D-printed midsole components. More specifically, two pairs of prototypes, that are made by the same material and appear the same, are in fact 3D printed using different structures.

3 Result and Discussion

In first phrase survey, five key scanning points, which affecting the pressure, comfort and shape of the footwear the most, were analyzed by using descriptive statistics; the average values are: (1) mean height: 162 cm; (2) mean weight: 54 kg; (3) mean size: 37;

(4) mean foot length: 237 mm; and (5) mean foot width: 89 mm. These mean values are based on the full sample size of 30 subjects, whereas the prototype was designed based on 10 selected subjects.

3.1 Groups Mean Comparison

A T-test was applied to analyze the two groups of means in Table 1. Two groups of subjects, size 37 and 38, are divided. Coherent result has been found in which it aligns with the means finding result of the five key scanning points. Only foot length has a significant difference between the 2 groups of subjects in the test and this was possible and reasonable since the 2 groups of subjects were divided by the EU size 37 and 38. In average, the subject height and weight to apply pressure to the sole of the footwear in size 37 and 38 are very similar.

Table 1. Means of key scanning points

Independent Samples Test

		t-test for Equality of Means		
		t	df	Sig. (2-tailed)
Height (cm)	Equal variances assumed	-.207	28	.837
	Equal variances not assumed	-.207	12.428	.839
Weight (kg)	Equal variances assumed	-.100	28	.921
	Equal variances not assumed	-.155	27.104	.878
Foot Length (mm)	Equal variances assumed	-6.958	28	.000
	Equal variances not assumed	-7.316	13.757	.000
Foot Width (mm)	Equal variances assumed	-.252	28	.803
	Equal variances not assumed	-.267	13.990	.793

In second phrase survey, a 3D-printed midsole can provide a comfortable experience to the foot after reviewing users' ratings on the performance of the prototypes. Figure 1 shows the combination of 3D printing structures, such as AA (small filaments without holes), CC (hexagonal pattern), AC (fore sole: small filaments without holes, and back sole: hexagonal pattern), and CA (fore sole: hexagonal pattern, and back sole: small filaments without holes). These structures can provide a comfortable environment for foot movement, and its materials and 3D-structure can offer greater softness for higher flexibility of the foot.

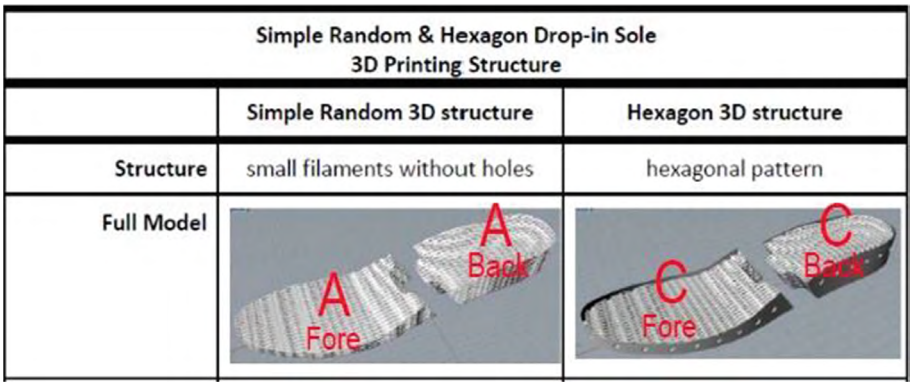


Fig. 1. Two structures: AA (small filaments without holes) and CC (hexagonal pattern) of 3D printed midsoles

The flexibility of the assembly of the 3D drop-in midsole for users was important for the future production. By applying the descriptive statistics analysis, it was easy to remove the 3D drop-in midsole from the shoes for users in the trials. The production of the drop-in sole joint could be improved for user-friendly design structure.

In the comfort assessment, the simple structure gave a comfy environment for foot movement. Figure 2 shows different structures that are below average in the users' rating.

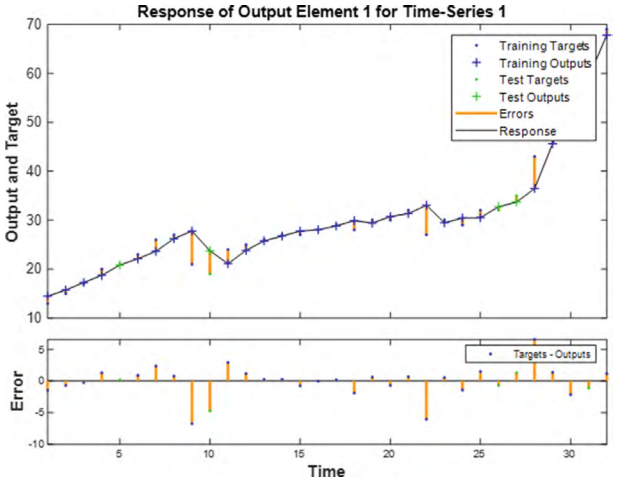


Fig. 2. Performance - comfort assessment rating

Figure 3 shows the simple 3D structure, fore- and back-sole. The simple 3D structure generally receives a comparatively satisfying performance from the subjects' user experience. The simple structure and design give a comfy environment and contact for foot movement. The average mean of rating for the perception of comfort is high. Both materials and 3D structure can offer greater softness and higher flexibility for the foot.

3D structures are constructed with small filaments which can offer good performance for support, and high softness and endurance to embrace the feet in daily activities. The 3D-printed midsole is a technological improvement of the cushioning [9] which is a new type of material for cushioning the shoes and related injury, pain, comfort, and discomforts. Comfort is also linked to energy dissipation and material resistance or stiffness. Compared to a midsole, an insole has less shock attenuation ability because of its thinness [10]. Thus, Fig. 4 3D-printed midsole can provide the softness and stiffness structures. To enhance the smart sensor design and development, comfort also needs to be incorporated with the smart sensors.

In the comfort assessment, it shows that only the pair of fore- and back-sole, AA (small filaments without holes structure) (red line), is below average in the users' rating. In other words, it is clear that a shoe with the AA structure is the most comfortable pair of soles among the four prototypes.

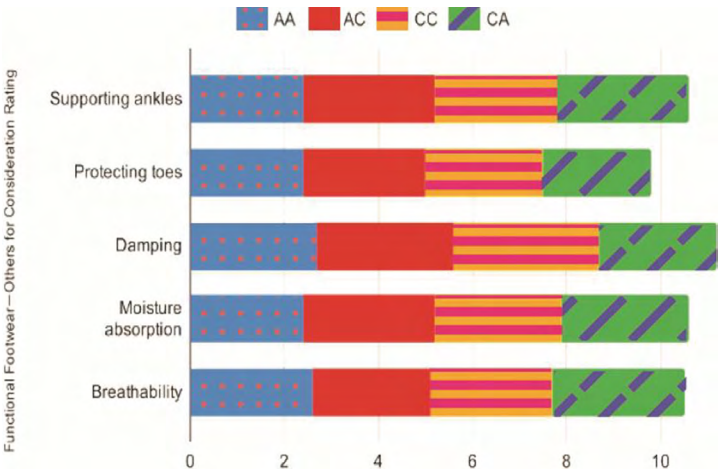


Fig. 3. Perception of comfort rating means (left)

For the perception of comfort, after generating the means from the ratings, the pair of insole, a shoe with the AA fore- and back-sole (blue line), generally has a comparatively steady performance. On the contrary, a shoe with the CA fore- and back-sole (green line) obtains the poorest performance in which all the ratings are lower than average.

In Table 2 according to the findings, the mean peak bound force between AA, AC, and CA pair soles are very different. It shows that the AA and AC pair soles have the lowest peak bound force. In other words, these 3D printing combination structures (1) fore sole: small filaments without holes; back sole: small filaments without holes, and (2) fore sole: small filaments without holes; back sole: hexagonal pattern, are the strongest mid-soles to provide flexibility and comfort, and even protection to the human foot. As a result, AA and AC drop-in soles can offer a better footwear environment to customers providing more softness, higher comfort levels, and greater flexibility in foot movement for daily wear.

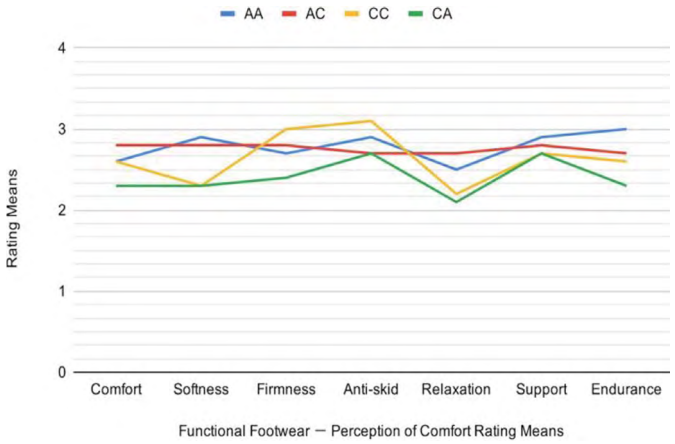


Fig. 4. Functional footwear - others for consideration rating (right)

Table 2. The results of the Friedman test showed that conditions of walking AA, AC, CC and CA (walking, unit: N/kg) were observed, χ^2 (2) = 0.600, p = 0.896.

Ranks	
	Mean Rank
AA-Walk	2.50
AC-Walk	2.50
CC-Walk	2.25
CA-Walk	2.75

Test Statistics[a]	
N	8
Chi-Square	.600
df	3
Asymp. Sig.	.896

a. Friedman Test

[p<0.05 is significant; p<0.01 is very significant; p<0.001 is highly significant]

In conclusion, the pair of shoes with fore- and back-sole can provide a comfortable environment and contact to the foot movement, meanwhile, its materials and 3D-structure can offer greater softness for higher flexibility of the foot.

However, the shape and protection of the drop-in sole, AA, should be improved by invoking the pairs of soles, AC and CC, with the highest ratings in the functional footwear part, in order to produce a pair of comfortable drop-in soles with upgraded protective functions in the market in the future.

4 Conclusion

A functional 3D printed midsole design has been initially approved and can provide comfort, customization, and sustainability [11].One significant factor for creating a sole

is the wearing comfort. Using 3D foot scanned images of the targets' foot and a customized 3D printed midsole, it is possible to eliminate the manufacturing process and to enhance sustainability in the production stages. Finally, the customized midsole can boost wearing comfort and consequently reduce the risks of falling.

The 3D printed midsole technology can bring in impacts in the footwear industry, such as many popular and marketable health improvement products that are created by a lot of research projects [12]. This technology can save time and materials used in the manufacturing process and fulfill citizens' needs by promoting more environmental-friendly products in the future [6]. To advance the application of smart insoles, this research project will further analyze and investigate 3D-printed midsoles with innovative pressure sensors.

Acknowledgments. The research was fully supported by a grant from the Technological and Higher Education Institute of Hong Kong's Seed Grant Scheme (Project No. SG1819107).

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Human-Technology and Future of Work



Proactive Competence Management for Employees: A Bottom-Up Process Model for Developing Target Competence Profiles Based on the Employees' Tasks

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Abstract. In order for industrial companies to continue to succeed in dynamic, globalized markets, they must be able to train their employees in an agile manner and at short notice in line with the exogenous conditions that arise. For this purpose, it is indispensable to operate a proactive competence management system for employees that recognizes qualification needs timely in order to be able to address them promptly through qualification measures. However, there are hardly any approaches to be found in the literature that include systematic proactive competence management. In order to help close this gap, this publication presents a process model that systematically develops bottom-up, future-oriented target competence profiles based on the tasks of the employees. This process model provides industrial companies with a tool that they can use to determine the competencies required by their own employees in the future and compare them with the prevailing actual competencies.

Keywords: Dynamic globalized markets · Employee competence management · Industrial companies · Knowledge management

1 Introduction

A central key to the success of an industrial company is suitably qualified employees [1]. They are the basis for ensuring that the company's value-adding processes can result in a high-quality product with which customer expectations can be met [2]. However, the increasingly dynamic, globalized markets with the growing number of competitors now mean that the frequency of product technology leaps is increasing or the life cycles of products are becoming even shorter [3]. For value-adding processes, the higher frequency of technology leaps results in increasingly frequent profound impacts that must be managed with suitably qualified employees [2, 4, 5].

One industry that will face countless product technology leaps and corresponding qualification needs in the near future is the commercial vehicle sector. For example, in the foreseeable future, commercial vehicle manufacturers will see the electrification

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 1123–1130, 2022.
https://doi.org/10.1007/978-3-030-85540-6_144

of the powertrain, digitization of the cab, autonomous driving, and increasing vehicle connectivity [6–9].

To be able to cope with the changing qualification challenges as an industrial company due to the increasing number of technology leaps, a systematic, agile and proactive competence management is needed [2]. However, there are hardly any approaches to be found in the literature that encompass such competence management. Most published competency management models are simply based on breaking down a company's long-term strategy top-down into individual employee target competency profiles and then using a target/actual competency analysis to trigger required qualification measures (see, e.g., models Horvat et al. [10]; Schuler [11]; Anzengruber and Bernard [12]; Cravens et al. [13]). This means that the target competence profiles are developed too late (unsystematically and reactively) in these models, which also delays the start of employee qualification with regard to the product technology leap. In the worst scenario, essential qualification needs remain unmet, jeopardizing the company's competitiveness or profitability due to frictional losses and defective products [2].

This paper introduces a process model that is intended to enable industrial companies to systematically, agilely and proactively develop target competence profiles for employee qualification for product technology leaps. The basic idea is to systematically construct bottom-up target competence profiles based on the expected future tasks of the individual employee groups. In this context, an employee group is considered to be a group of employees who perform the same tasks in the identical department (e.g. assembly employees in production).

2 Structural Design of the Process Model

The fundamental challenge in developing the process model was to find a systematic path from the expected future tasks of the respective employee group to the required target competencies of the employee group. In addition, the model also had to be practice-oriented, i.e. it had to be applicable by an industrial company without major adaptations and difficulties in understanding.

In the end, a model structure consisting of two levels proved to be goal-oriented. The upper level contains the concrete steps that an industrial company must take in order to obtain the future-oriented target competency profiles for the employee groups. The totality of these steps resembles a guideline. The lower level contains the individual instruments or tools to be used in carrying out the individual steps from the upper level.

3 Instruments of the Process Model (Lower Model Level)

This subchapter will now explain the lower level instruments. The instruments are the following three: Task scenario analysis, target competence profile of an employee group and translation matrix. Regarding the timing and type of use of these instruments in the process model, please refer to the 4th chapter *Steps of the process model* (upper model level).

3.1 Task Scenario Analysis

The purpose of the task scenario analysis is to examine a task of a homogeneous employee group for probable changes in content regarding a concrete upcoming technological leap. In the first phase, this task must be defined in key words by a manager of the employee group. In the second phase, a representative of the HR department must analyze this task, which has been defined by the specialist department, together with a proven expert for the technology leap under consideration. In other words, based on the expert's know-how, changes that are likely to occur with regard to the employee task triggered by the technology leap must be identified. The expert can be either a person from the specialist department or an external person. The expert only needs to have a good knowledge of the technology leap and be able to assess the department from which the task originates. For the documentation of the results of the task scenario analysis, the layout shown with the following table can be used (Table 1).

Table 1. Layout proposal for the documentation of the task scenario analysis.

Technology leap of the scenario analysis …			
Employee group	Task of the employee group	Task ID	Task scenario for technology leap
…	…	…	…
…	…	…	…

3.2 Target Competence Profile of a Group of Employees

A target competency profile represents a target image for the skills or competencies of an employee group that is directly related to the tasks to be performed by the employee group in the future. In other words, it is an instrument for individually identifying competence gaps in the respective employee groups and proactively eliminating them by means of subsequent qualification measures. The target competency profiles that result from the application of the process model are made up of a total of two elements. First, a profile has a set of 15 single competencies. These can be of a professional, social or personal nature. How many competencies of which type are used for a profile is not specified. Secondly, four proficiency levels are assigned to all single competencies. This proficiency level scale always ranges in whole numbers from 0 (basic competency proficiency) to 3 (expert competency proficiency). For a specific target competency profile, a target proficiency level must be specified on this scale for each single competency. As an example, the following figure shows a fictitious target competency profile (Table 2).

Table 2. Example of a target competency profile (fictitious).

Target competence profile for group of employees		Technical sales manager	
Single competence (I/II)	Target proficiency level of the single competence	Single competence (II/II)	Target proficiency level of the single competence
1: Dealing with customers	3	9: Renewability	1
2: Conflict skills	2	10: Decision-making ability	1
3: Intercultural openness	1	11: MS Office skills	2
4: Self-organization	2	12: Ability to work in a team	1
5: Sense of responsibility	1	13: Presentation skills	3
6: Negotiability skills	3	14: Legal fundamentals	3
7: Flexibility	2	15: Compliance knowledge	3
8: Technical knowledge	2		

3.3 Translation Matrix

The translation matrix represents the instrument with which an employee group task defined by the manager and examined as part of the task scenario analysis can be translated into a task-specific target line for the target competence profile to be developed. Once the set of 15 single competencies has been determined, this tool can be used to determine a target level of proficiency for each of the 15 single competencies for the defined and scenario-analyzed employee group task. Specifically, the translation matrix is based on a pool of a total of 30 generic task characteristics (e.g., time pressure), which in turn are assigned to four qualitative specifications (e.g., time pressure: none/low/medium/high). This pool is shown below (Table 3).

Table 3. Pool of a total of 30 generic task characteristics.

Generic task characteristic	Four qualitative specifications	Generic task characteristic	Four qualitative specifications	Generic task characteristic	Four qualitative specifications
Frequency	*None low medium high*	Responsibility	*None low medium high*	Change of location	*None low medium high*
Timeliness	*None low medium high*	Data volume	*None low medium high*	Movement	*None low medium high*
Spontaneity	*None low medium high*	Interfaces	*None few some many*	Load	*None low medium high*

(*continued*)

Table 3. (*continued*)

Generic task characteristic	Four qualitative specifications	Generic task characteristic	Four qualitative specifications	Generic task characteristic	Four qualitative specifications
Time expenditure	*None low medium high*	Number of objects	*None few some many*	Risk	*None low medium high*
Time pressure	*None low medium high*	Object complexity	*None low medium high*	Susceptibility to error	*None low medium high*
Team size	*None small medium large*	Task steps	*None few some many*	Trust	*None low medium high*
Involved people	*None few some many*	Company specific	*None low medium high*	Innovation	*None low medium high*
Interdependence	*None few some many*	Communication	*None low medium high*	Freedom	*None low medium high*
Customer contact	*None few medium many*	Computer	*None low medium high*	Creativity	*None low medium high*
Conflict potential	*None low medium high*	Machine	*None low medium high*	Regulations	*None low medium high*

A ready-made, directly usable translation matrix cannot be presented in this paper, as it is always company-specific. For the construction of the translation matrix, at least 5 generic task characteristics must be selected from the pool for each single competency of all target competency profiles, which are most closely related to the respective single competency (e.g. generic task characteristic "time pressure" for employee task "preparation of a cost report in controlling"). Subsequently, the qualitative specifications of the selected task characteristics must be assigned to the proficiency levels of the respective single competencies in a table - the translation matrix with the single competencies in the rows and the task characteristics in the columns is created. For illustration purposes, the following table contains a section of a fictitious translation matrix (Table 4).

Table 4. Fictitious translation matrix.

Competence	Proficiency level scale	Selected generic task characteristics (most closely related to the competence, at least 5 per competence)					
Flexibility		Frequency	Adherence to deadlines	Spontaneity	Time expenditure	Time pressure	…
	0	One-time	None	None	None	None	…
	1	Few	Low	Low	Low	Low	…
	2	Some	Medium	Medium	Medium	Medium	…
	3	Many	High	High	High	High	…

(*continued*)

Table 4. (*continued*)

Competence	Proficiency level scale	Selected generic task characteristics (most closely related to the competence, at least 5 per competence)					
Conflict skills		…	…	…	…	…	…
	0	…	…	…	…	…	…
	1						…
	2						…
	3						…
…	**…**	…	…	…	…	…	…

4 Steps of the Process Model (Upper Model Level)

Overall, the process model for developing future-oriented target competence profiles of homogeneous employee groups consists of *six steps* as shown below (Table 5).

Table 5. Six steps of the process model.

Number of the step	Step
1	Definition of the scope of the application for the process model
2	Identification and documentation of the tasks of the employee groups
3	Execution of the task scenario analysis for the identified employee group tasks
4	Creation of a change overview for each employee group
5	Development of the first element of the target competency profiles for each employee group
6	Completion of the target competency profiles for each employee group

In the *first step*, the industrial company must define the scope of application for the process model. This means that, on the one hand, the company's executives must determine the imminent technological leap that will change the company's own products or value creation processes to such an extent in the medium term that the application of the model will also bring corresponding benefits. On the other hand, it must be decided which employee groups are to be considered for the application. Managers from the respective departments of the employee groups are the right contacts for this.

The *second step* pursues the goal of identifying the individual daily tasks of the employee groups selected for the model application and documenting them in note form. Small bilateral discussions between the employee groups and the managers in the departments are recommended for this purpose, since the employee groups know best what the daily tasks represent and the managers ensure objectivity.

The *third step* is to perform the task scenario analysis for the employee group tasks documented in the previous step with respect to the technology leap defined in the first step. For a description of how the task scenario analysis is performed, please refer to Subsect. 3.1.

The goal of the *fourth step* is to create a change overview for each employee group. Thus, the probable changes due to the technology leap in the individual employee group tasks identified in the third step must be summarized so that an overview is created for each employee group.

In the *fifth step*, the first element of the target competency profile is to be developed for each employee group using the set of 15 single competencies. This requires the managers of the departments to work with HR to define the set of 15 single competencies for each employee group based on the current employee group tasks documented in the second step and the change overviews developed in the fourth step. Only the current employee group tasks in combination with the change overviews provide a comprehensive picture of the future employee group tasks and thus form a suitable basis for this fifth step.

The completion of the future-related target competence profiles takes place in the *sixth step*. In other words, the target proficiency levels must be determined for all the individual competencies in the single competency sets using the translation matrix. In concrete terms, this involves first translating the individual tasks with the scenario-based changes for each employee group into a target proficiency level for each single competency in the employee group's single competency set. This means that if, for example, 23 tasks have been documented and analyzed scenically for an employee group, each single competency of the single competency set of this employee group has a total of 23 target proficiency levels after this first sub-step. However, in order to arrive at a final target proficiency level per single competency of the respective set and thus at the finished employee group target competency profiles, the many target proficiency levels per single competency from the first sub-step must finally be evaluated using the statistical mode. For the construction of the company-specific translation matrix, please refer to Sect. 3.3, and for an explanation of the target competency profiles resulting from this process model, please refer to Sect. 3.2.

5 Conclusion

The process model developed as part of this work represents an effective tool for industrial companies that want to systematically, agilely and proactively develop target competence profiles for employee qualification for product technology leaps. The relevance of this model is further enhanced by the increased frequency of technology leaps in the context of dynamic globalization.

The systematic, agile and proactive nature of this model results from its bottom-up basic structure. In other words, based on the expected future tasks of the employee groups, future-related target competency profiles are constructed in sequential bottom-up steps.

More specifically, the systematic nature of the model is generated by the steps described in a guideline-like manner (upper model level). Agility in turn results from the fact that the model can be applied at short notice for any product technology leap and

any employee group with a reasonable amount of effort. The proactivity of the model can be attributed to the task scenario analysis, as this allows target competence profiles to be developed at an early stage or with foresight.

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Survival of Fittest: Open Innovation and Product Development Linkages

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Abstract. Open innovation is becoming the frontline strategy to develop new products and services in most R&D based firms. This paper focuses on the strategies of the companies which protect their R&D capabilities and their effect on the open innovation process in new product development. The theoretical framework of this research was extracted from open innovation, product development and management science literature. Data from 20 countries have been collected from 60 open innovation and intensive R&D dependent firms. Statistical techniques were used to analyse the data. The data analysis showed five protectionist motives involved in open innovation-based product development between companies. The results provided the validation of the theoretical framework and explored these motives based on managers' feedback. The study implies strong linkages between open innovation, product development and protectionist motives of companies.

Keywords: Open innovation · Product development · R&D · Protectionist motives

1 Introduction

Innovators are emerging saviours, helping to save organisations with the induction of new products and services [1]. Innovation is a crucial element for a new product development (NPD), independent of being developed in-house or in an external R&D setting [2]. Today, the ever-increasing competition forces companies to develop products in open innovation (OI) environments to get the best possible results. Henry Chesbrough defined OI as, "the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively. [This paradigm] assumes that companies can and should use external ideas as well as internal ideas, and internal and external paths to market, as they look to advance their technology" [3].

Open innovation is prevailing in NPD when it comes to utilising external ideas and brings new challenges to collaborators [4]. The purposive use of external partners to develop and market newly developed products pose challenges to parent companies' R&D [5]. The highly external R&D dependent companies somewhat weaken their R&D capabilities [6]. Still, many companies are inclined to open innovation-based NPD and survive well in the competitive market [7]. The OI allows such companies to avoid

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 1131–1137, 2022.
https://doi.org/10.1007/978-3-030-85540-6_145

freedom of commitment to dedicate enormous permanent resources for internal R&D [8] and somehow balancing the loss in terms of compromised R&D unit [9].

The literature shows different factors involved when companies collaborate to develop an open innovation-based product [10]. Studies show that protection of in-house R&D is somehow linked with the providers' (contract research organisations or CROs) country environment, reputation or characteristics for overall OI collaboration, and evaluation of OI's pros and cons [6]. Some studies have emphasised linkages of OI based developed product performance in the market and cost-effectiveness with the protection of in-house R&D [11]. However, past and current research cannot provide comprehensive insights about the overall open innovation-based product development and the protection of in-house R&D capabilities during this development. The literature also fails to evaluate the impact of companies' protective measures on open innovation-based product development. Against this background, the purpose of this paper is to answer the following **research question (RQ):**

"How do (parent) companies protect R&D capabilities and how do these protectionist motives affect open innovations in the product development process?" [6].

More specifically, this study has two main objectives:

- To explore protection of R&D capabilities in companies in product development
- To examine the effect of protective measures on open innovation in product development.

The paper has four parts. First, it describes related background research followed by a framework, then the research methods are presented. Next, the findings and analysis are summarised. The article ends with a discussion, conclusion and limitations, containing managerial implications and scope for future research.

2 Research Background

Companies are in survival of the fittest race, to stay ahead of their competitors in their respective markets [12]. As Joy said in 1995, "the smartest people in the world do not all work for us" [13] indicating that working in collaboration was most likely to happen in the future. Companies collaborate at various levels, but cooperation for R&D related projects is not so simple as cooperation at the general level [14]. The reason behind fears of R&D cooperation is the chance of losing core competencies if anything goes wrong which can cost companies their fortune or, in some cases, close the whole business [15]. The open innovation concept is based precisely on similar types of R&D collaborations and cooperation where companies do purposive inflow of knowledge [3].

The concept of 'Connect and Develop' also complements the similar way of R&D collaborations at various levels [16]. When companies connect for the sole purpose to develop new products and compete in their respective market, OI comes into play [10]. There are many reasons why companies go into OI or similar settings to develop products such as CROs country environment, cost-effectiveness, speeding up the development process, CROs viability for product development and evaluation of pros and cons of OI [17].

However, competing in the market and OI based product development also poses threats to parent companies' R&D capabilities [5]. Protection of in-house R&D and core competencies is sometimes the dilemma for companies undergoing OI-based product development [8]. On one end, this has promoted the concept of OI innovation and on the other end, causes leakage of core competencies and threatens the protection of in-house R&D [18]. It is believed that OI based product development is mostly carried out to achieve cost-effective products, thus implying transaction cost economics theory (TCE) [18]. Literature also explains the importance of internal resources and their best utilisation, based on a resource-based view (RBV) [19]. Although TCE and RBV provide the basics of such collaboration in the OI setting between companies, there is no direct study available to establish the linkages and impacts of OI, product development and protection of in-house R&D. This highlights the major research gap in the literature.

3 Research Framework and Hypotheses

Companies try their best to protect their core competencies and R&D with the available resources [5]. Many initiative companies take protectionist motives to consolidate their R&D capabilities while developing products in open innovation collaboration with other companies, firms and innovation providers. This paper focuses on five factors and their linkages with the protection of in-house R&D, product development and open innovation. The following are five hypotheses described:

H_1: The protection of in-house R&D is directly proportional to the characteristics of open innovation (OI) providers/hosts/partner country environment and their influence on the overall process
H_2: CRO reputation/characteristics/viability for overall OI process is/are directly proportional to Protection of in-house R&D
H_3: The pros and cons of OI is directly proportional to the protection of in-house R&D
H_4: The performance of an open innovation-based product is directly proportional to the protection of in-house R&D
H_5: The protection of in-house R&D is directly proportional to cost-effectiveness as the main reason for open innovation-based product development (Fig. 1).

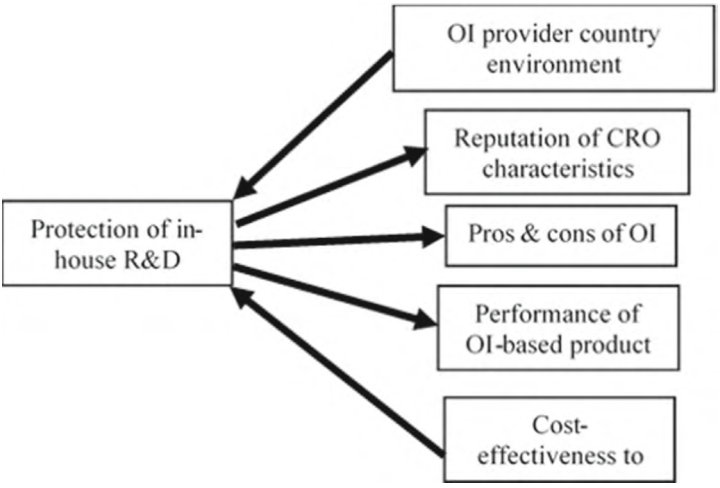


Fig. 1. Linkages between open innovation, product development and protection of R&D

4 Methods

This study's population sample consisted of employees, scientists, researchers, managers, and professionals with extensive experience working in open innovation and product development. The respondents were associated with 60 companies operating in 20 different countries at the data collection time (2016–2018). The unit of analysis in this overall research project was a respondent (employee, scientist, manager, professional or researcher) and a sampling unit was each involved company. There were 112 usable responses, with a 43% response rate. Data collection and handling was done according to the General Data Protection Regulation (GDPR) in the EU and the research was conducted without any incentive offerings. The survey had four parts and a total of 31 questions [6]. RQ answered using all related answers to protect in-house R&D, product development and open innovation concepts. The collected data from 10 industrial sectors, namely, the pharmaceutical industry, the ICT industry, life sciences, telecommunications, the chemical industry, robotics, logistics, engineering services, financial services and the automotive industry. These industrial sectors' selection criteria was mainly based on their close association with open innovation-based product development and vulnerable R&D departments. A Likert scale was used to form seven-point statements to collect feedback as an answer to different questions. The survey questions and their possible answers were based on relevant literature on open innovation, product development and the importance of in-house R&D capabilities. Although this article is part of a more significant research project completed and published, this article's scope is only limited to exploring the linkages between open innovation and product development process and their related impact on companies' in-house R&D capabilities.

Specific data about the performance of an in-house developed product and open innovation-based developed product were also collected and compared. From the overall dataset, 10.6% of respondents believed that inhouse developed products performed ***average***, while 18.6% said that the open innovation-based products performed ***better*** in

the related market. However, 8% of respondents believed that their innovative in-house products have ***better*** performance and success than open innovation-based products. Overall, there is slightly higher confidence in inhouse developed products compared to open innovation-based products. An in-depth analysis of these linkages is presented in the following chapters.

5 Analysis and Findings

The data was collected with the help of a self-designed research instrument. The five hypotheses were tested by running a correlation analysis on IBM SPSS24. In the quantitative data analysis, four of the hypotheses were validated by empirical investigation, while one of them was not supported. Table 1 shows all five hypotheses (H_1 to H_5). In the first hypothesis, the protection of in-house R&D is directly proportional to the characteristics of open innovation (OI) providers/hosts/partner country environment and their influence on the overall process, which was supported by statistical analysis ($p < 0.01$). H_2 and H_3 indicated that the protection of in-house R&D is related to OI's CRO characteristics and pros and cons. Both hypotheses were supported due to a significant relationship found in analysis ($p < 0.01$). The performance of an OI based product (H_4) has a significant relationship ($p < 0.05$) with the protection of in-house R&D. However, there is a non-significant relationship between the protection of in-house R&D and cost-effectiveness of OI based developed product, so H_5 is not supported. Findings show the linkages in the form of positive relationships between protection of inhouse R&D, OI pros and cons, CRO characteristics that collaborate in the development of OI-based products, and the CRO country environment OI-based R&D activities. Additionally, there are very weak or no linkages between the protection of in-house R&D and cost-effective OI based product development.

Table 1. Analysis of hypotheses using correlation function in SPSS

Hypo.	Parameters	Pearson correlation	Relationship sign.	p-value	Results
H_1	OI provider country environment	0.500^{**}	0.000	$p < 0.01^{**}$	Supported
H_2	Reputation of CRO characteristics	0.495^{**}	0.000	$p < 0.01^{**}$	Supported
H3	Pros & cons of OI	0.537^{**}	0.000	$p < 0.01^{**}$	Supported
H_4	Performance of OI-based product	0.202^{**}	0.032	$p < 0.05^{**}$	Supported
H_5	Cost-effectiveness to promote OI	0.130	0.173	Non-sig.	Not supported

** Correlation is significant at 0.01 level
* Correlation is significant at 0.05 level

6 Discussion and Conclusion

This paper explores the linkages between OI, product development and their relationship with the protection of in-house R&D capabilities of the company. This article's main contribution is to establish a statistical relationship and define the strengths of these linkages. The supported relationships loosely complement the work of Bogers [5] and Gassmann et al. [10] and additionally elaborate the linkages as the contribution of this research. The analysis shows that protection of in-house R&D is positively related to characteristics of OI providers' country environment (H_1), CRO reputation (H_2), Pros and cons of OI (H_3) and performance of OI based product (H_4). The impact of OI based products on the protection of in-house R&D has been suggested in earlier studies, but it has not been proven statistically. A closer view of this study's findings shows that OI-based developed products are influenced by their provider country's environment and related to the protection of in-house R&D of the company. These linkages extend the work of Cassiman and Valentini [8]. A more robust in-house R&D department positively impacts OI-based products because it can lead the product development process (as parent company) while conserving its core competencies. It also leads to the development of products with minimum chances of failure. The literature argues about the cost-effectiveness of the OI based developed products and their benefits. Still, this study shows that cost-effectiveness has a negative effect on companies in-house R&D and core competencies in the long run. So, cost-effectiveness should not be the only reason to go into OI based product development.

These findings help to validate this research's theoretical framework and identify the linkages between OI and product development regarding the protection of in-house R&D capabilities. When going into OI-based contracts to develop products, these findings can help to form standard operating procedures (SOPs) ahead of similar bindings. During data collection, a wide range of demographics was a fundamental limitation of this study, as data was collected from 20 countries with entirely different circumstances for protection of R&D.

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Latency in Cyber-Physical Systems: The Role of Visual Feedback Delays on Manual Skill Learning

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Abstract. To inform, guide and optimize the design of cyber-physical systems (CPS), this study examined whether and how delayed visual feedback affects human fine-motor skills. Two experiments are presented, in which participants performed a complex motor task with their hands. During the task, visual feedback was provided on a display with varying delay lengths. Further, to investigate effects of adaptation and transfer, some participants were first exposed to a fixed delay before performing the task with varying delay lengths. Results show that independent of earlier delay exposure feedback delays had detrimental effects on performance, particularly when performance information was lacking and delay length variable. Hand kinematic indicate the use of a strategy geared to a slowing of the movement process. Implications and future research ideas like the application of augmented feedback on movement kinematic and the examination of different settings to promote adaptation effects are discussed.

Keywords: Human-machine interaction · Latency · Delayed visual feedback · Adaptation · Fine-motor skills

1 Introduction

Latency is an issue affecting the technological progress in various applications with high demands on human motor control. The interaction between humans and cyber-physical systems (CPS) is often characterized by a high density of information and computational complexity. As a result, feedback to the human user can be delayed—with potentially fatal consequences (e.g., injury in telesurgery [1], accidents in aircraft control [2]). Besides the constant effort to alleviate system delays, research on human motor control might help to overcome detrimental effects. In particular, the identification of boundary conditions and the examination of compensatory mechanisms could inform, guide and optimize the design of human-CPS interactions.

In visuomotor learning, it is known that delays between action and visual feedback on the outcome affect motor execution. Naturally, there is a delay between an action and the

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 1138–1146, 2022.
https://doi.org/10.1007/978-3-030-85540-6_146

information reported back by the sensory systems. Therefore, humans use an internal model (i.e. forward model) to predict the consequences of their motor commands to successfully plan and control their actions [3]. These predictions are later compared with and corrected based on sensory feedback to further improve motor control. Congruent multisensory feedback facilitates motor learning [4], whereas incongruent information, e.g. due to delayed feedback disturb motor control [5].

During human-CPS interaction, technology adds latency to the control loop and thereby can affect humans' performance. For instance, in a video game study, steering a character through a virtual world was impaired for a feedback delay of 150 ms [6]. In another study using virtual reality (VR), participants had to mimic the movements of an avatar. The motor performance already worsened, when visual feedback—a second avatar mirroring the participants' movements—was delayed by 75–125 ms [7].

Nonetheless, as the internal model of the body and the world is constantly updated [3], users can also adapt to artificial delays. Different mechanisms are discussed to cause this compensatory effect, for instance, a change in the prediction and therefore in the degree of the sensory prediction error, as well as increased sensitivity to this error [8]. For the former, adaptation effects would be specific to only one delay length, for the latter, they are supposed to transfer to delays of similar length.

Critically, most research on the impact of feedback delays on human motor control employs rather simple tasks with movements in one- or two-dimensional (2D) space, which might be differently affected by system latency than movements in 3D space [9]. Therefore, it is an open question of how delayed visual feedback influences fine-motor skills. Two experiments were conducted (1) to identify processes affected by visual feedback delays during a complex motor task, (2) to determine how these processes are related to task performance and (3) how they change with adaptation.

2 Experiment 1

Experiment 1 examined the impact of varying visual feedback delays on movement execution in a complex motor task. Research with 2D tracking tasks showed detrimental effects of such delays on performance [10, 11]. Further, movement kinematic indicated changed control strategies. Particularly, the frequency of corrective movements, so-called intermittencies, are often reduced or movements slowed down [12].

Critically, in the different application areas of human-CPS interaction, compared to most lab-based tasks, movements differ regarding the number of degrees of freedom and the haptic and proprioceptive information available [13]. Further, for most applications, self-initiated movements seem more common than target tracking and thereby rely differently on feedforward and feedback processes [3]. These differences might also change the impact of feedback delays on task performance and movement strategies. Therefore, this experiment examined, how fine-motor skill performance and movement kinematic in a complex motor task is affected by visual feedback delays.

2.1 Methods

Participants. Ten healthy, right-handed students (six females; age: 24–40 yrs., M = 27.4) took part in the experiment. Informed written consent was obtained before the

investigation which was conducted in line with the declaration of Helsinki and approved by the ethics committee of the TU Dresden (SR-EK-207052020). After testing, students received either 20 Euro or course credit for their participation.

Task and Procedure. The experiment built on the Wire Loop Game (WLG), where a loop has to be moved quickly along a wire without touching it. The game was placed in front of the participant with visual feedback on participants' hand movements provided on a display only. The scenery was videotaped from an opposite viewpoint and then mirror flipped for presentation (Fig. 1 illustrates the experimental setup).

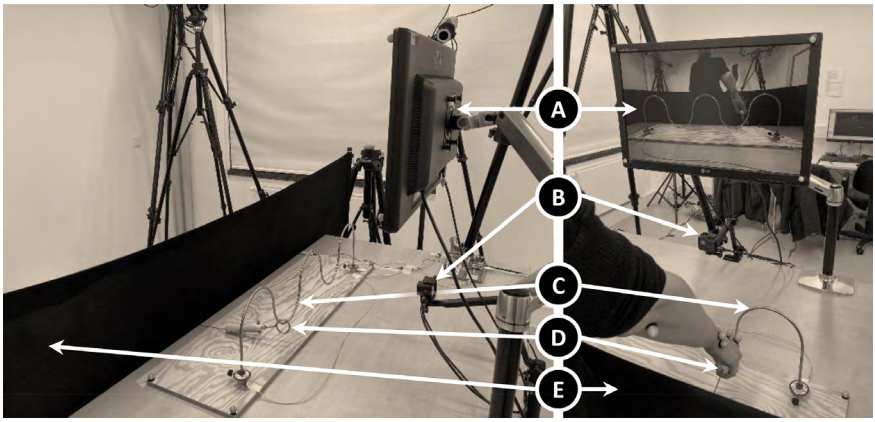


Fig. 1. Experimental setup from two perspectives (*left and right*) with key elements: screen with live video (*A*); camera (*B*); the wire (*C*); stick with eyelet, i.e. loop (*D*), black fabric (*E*).

The WLG was controlled with a Raspberry Pi 4. Another computer controlled the visual feedback by manipulating the video signal, which was recorded with a GoPro HERO7 and then captured by the Blackmagic Intensity Pro 4K. The live video was shown on a 24-Zoll screen (60 Hz) with an internal delay of ~17 ms. For the video replay, additional latency was introduced to the buffered video data. The delay length, prescribed in the experimental protocol, was signaled from the Raspberry Pi via TCP. Participants' movements during the task were tracked using an optical motion capture system from Qualisys with six cameras (Miqus M3) connected to a computer, which was running the Qualisys Track Manager (QTM 2020.1).

In the beginning, markers were attached to the participant's right hand, wrist, elbow, and both shoulders to track arm and hand movements [14]. Static recordings of the arm/hand were made to later fit an arm model to the movement data. Dynamic recordings were used for an integrated *Automatic Identification of Markers* (AIM) model in QTM, facilitating the marker tracking during task completion.

Participants were instructed to perform the task as fast and accurately as possible by only looking only on the screen. During the following ten practice trials, the video feedback was not delayed. Then, in three test blocks of 13 trials each, delays with a length between 0–204 ms (17 ms increments) were introduced to the video signal. The order

was randomized and participants were only informed that the feedback could be delayed to some degree. Throughout the task, additional real-time auditory feedback (buzzing sound) was given every time the loop made contact with the wire. Testing lasted about 1.5 h. Participants' performance in the game (speed, accuracy) and movement execution (kinematics of the hand trajectories) were recorded.

Data Analysis. Performance and movement data were aggregated across trials with short (17–68), medium (85–136) and high (153–204) delay length. Participants' speed was defined as the duration for completing a trial. Accuracy is reflected by the accumulated contact time during a trial. For motion data, the number of intermittencies was determined as follows: Visual 3D (C-Motion Inc.) was used to build an arm model [14] and to extract kinematic data. A hand body segment was modelled from the static recordings and applied to the motion data from the task. Data were preprocessed (cf. Visual 3D documentation) and acceleration-time curves of the hand (x-, y-, and z-direction) per trial and participant were generated. The number of intermittencies was computed using Matlab 9.6 (2019). Following earlier work [11] and considering the third movement dimension in this task, intermittencies were defined as zeros of the three acceleration functions that coincide in time. Repeated measures analyses of variance (RM-ANOVAs) were computed with delay (low, medium, high) as within-subject factor and duration, contact time and the number of intermittencies as dependent variables. Further, Spearman's correlation between performance and movement data were computed. For all analyses, a rejection criterion of $p < .05$ was chosen.

2.2 Results and Discussion

The main findings are illustrated in Fig. 2A. The RM-ANOVAs revealed significant effects of *Delay* for duration, $F(2, 18) = 5.04$, $p = .02$, $\eta^2 = .36$, and number of intermittencies, $F(2, 18) = 4.55$, $p = .03$, $\eta^2 = .34$, but not for contact time, $F < 1$. Polynomial contrasts testing a linear component suggest increased durations, $F(1, 9) = 5.76$, $p = .04$, $\eta^2 = .39$, and a higher number of intermittencies, $F(1, 9) = 5.92$, $p = .04$, $\eta^2 = .40$, the longer the delay was. Further, we obtained positive relationships between the number of intermittencies and duration, $\rho = 0.91$, $p = 0.001$, and contact time, $\rho = 0.35$, $p = 0.001$, respectively.

The findings on the impact of feedback delays on performance partly replicate earlier evidence obtained from simple tracking tasks [12]. Also for complex motor tasks, humans seem to slow down instantly when exposed to visual feedback delays. Interestingly, accuracy (i.e. contact time) in this experiment was not affected by the feedback delay. Besides the small sample size and low power of the study, the constant auditory feedback on movement accuracy but not speed could be one reason. Augmented feedback can enhance motor performance, especially in complex motor tasks [15]. Therefore, future studies should examine whether multisensory feedback helps to compensate detrimental effects of visual feedback delays. These studies may consider different scenarios, e.g. tasks with time pressure, and different feedback contents like performance measures or movement kinematic.

A second interesting finding of this experiment is the delay-induced change of movement kinematic and its relation to performance. In contrast to earlier evidence regarding

movement kinematic in 2D tracking tasks [10, 12], intermittencies became more frequent with longer feedback delays. This movement pattern might reflect a different control strategy for fine-motor skills when they are self-induced and less target-dependent [11]. However, the strong positive correlation between the number of intermittencies and the duration for completing the task suggests a strategy, which is—similar to the reported behavior in 2D tracking tasks with visual feedback delays [12]—geared to a slowing of the movement process to keep control.

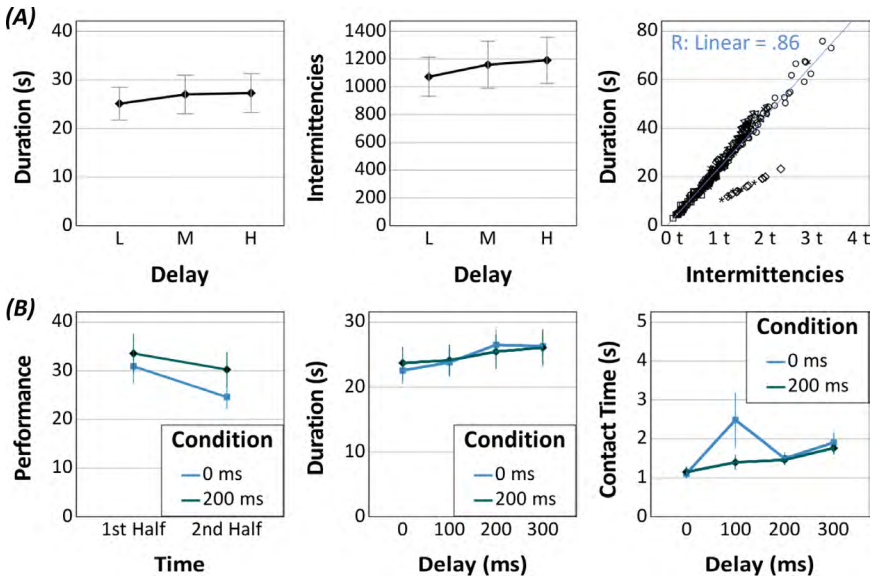


Fig. 2. (***A***) Experiment 1: mean duration for task completion (*left*) and the average number of intermittencies (*middle*) for feedback delays of low (*L*), medium (*M*) or high (*H*) length, and the relationship between the number of intermittencies and the duration for task completion across trials (*right*); (***B***) Experiment 2: mean performance scores for the first and second half of the learning phase (*left*), and the mean duration for task completion (*middle*) and contact time (*right*) during the test phase for delays of varying length; error bars indicate standard errors.

3 Experiment 2

Experiment 2 examined whether humans adapt to visual feedback delays after short exposure in a complex motor task. Further, the transfer of potential adaptation effects to different delay conditions was tested. While adaptation effects were found in simple lab-based tasks [8, 10], movement complexity can impact the time course of adaptation and benefits of delay exposure could tarry in complex 3D tasks [10]. Though participants compensated for delays of 200 ms dealing with a 3D tracking task [16], it is not clear whether improvements were due to adaptation or training as no control condition without delay was studied. Further, it needs to be explored whether adaptation is specific to only

one delay or transfers to delays of different length as in simple reaching movements [8]. These questions were addressed in this second experiment.

3.1 Methods

Participants. Twenty-three students were recruited for the experiment. Due to technical issues, two of them could not complete the study, resulting in 21 participants (16 females; age: 20–27 yrs., $M = 23.1$) included in the final analyses. All participants were right-handed except for one student with ambidexterity. As for Experiment 1, informed written consent was obtained prior to the study (ethic approval: SR-EK-207052020). Students received either 25 Euro or course credit for their participation.

Task and Procedures. The procedure was similar to Experiment 1 but comprised three parts: baseline, experimental, and control condition. In the twelve baseline trials, participants were exposed to visual feedback delays of varying length (0, 100, 200, and 300 ms). Mean performance (sum of duration and contact time) of the last four trials of the baseline without delay served as a performance criterion for the following two parts. Experimental and control conditions—each comprising a learning and a test block—were counterbalanced across participants. In the learning block, participants performed the task until the performance criterion was met for five consecutive trials—with a minimum of 16 trials to allow delay adaptation and a maximum of 24 trials to avoid fatigue. Only in this block, delay length differed between conditions. While in the experimental condition, participants were continuously exposed to a delay of 200 ms, no delay was implemented in the control condition to examine pure learning effects. After each trial, participants received verbal feedback on their performance (i.e., change in performance score). In the subsequent test block with twelve trials, feedback delays like in the baseline were introduced to asses transfer effects of potential adaptation. The trial order was randomized. The test session lasted for about 2.5 h. Participants' performance in the game (speed, accuracy) was assessed.

Data Analysis. Performance scores in the learning block were aggregated across trials of the first and second half of the block per condition (experimental vs. control) and participant. Performance data (duration, contact time) in the test blocks were aggregated across trials with the same delay length (four different delays) per condition and participant. A RM-ANOVA was computed with condition and time (fist vs. second half) as within-subject factors and the performance score in the learning blocks as the dependent variable. Two further RM-ANOVAs were performed with condition and delay (0, 100, 200, and 300 ms) as within-subject factors and duration and contact time in the test blocks as dependent variables. For all analyses, a rejection criterion of $p < .05$ was chosen (Bonferroni correction for posthoc multiple comparisons).

3.2 Results and Discussion

The main findings are illustrated in Fig. 2B. For the learning block, the RM-ANOVA revealed a significant effect of *Time*, $F(1, 20) = 23.81$, $p < .001$, $\eta^2 = .54$, indicating

better performance in the second half compared to the first. The effects of *Condition*, $F(1, 20) = 1.58$, $p = .22$, and *Condition* × *Time*, $F(1, 20) = 1.63$, $p = .22$ were not significant. For the test block, the RM-ANOVAs revealed a significant effect of *Delay* on duration, $F(3, 60) = 13.08$, $p < .001$, $\eta^2 = .40$, and contact time, $F(3, 60) = 2.98$, $p = .04$, $\eta^2 = .13$. Participants were faster for delays of 0/100 ms compared to delays of 200/300 ms. Further, compared to long delays of 200/300 ms, contact time was reduced, when no delay was added. The effect of *Condition* (duration: $F < 1$; contact time: $F(1, 60) = 2.11$, $p = .16$) and the interaction *Condition* × *Delay* were not significant (duration: $F(3, 60) = 1.55$, $p = .21$; contact time: $F(3, 60) = 1.79$, $p = .16$).

Findings from the test phase replicate results of Experiment 1 showing detrimental effects on performance that increase with longer delays. In this experiment, delays of 200 and 300 ms had a particular impact on both speed and accuracy, which corresponds with earlier findings from a simple 2D tracking task [11]. Further, detrimental effects occurred regardless of earlier exposure to a feedback delay. Since no adaptation was found in this phase, longer exposure time might be crucial for motor adaptation in complex tasks [10]. The missing depth information made the task particularly demanding and 2D visualizations are processed less efficiently compared to 3D visualizations [17]. This might have also affected the time course for adaptation, which could tarry if required resources are engaged in other aspects of the task [18].

Interestingly, in the learning block, there was no significant difference between the two delay conditions of 0 and 200 ms. This might be due to the performance feedback participants received after each trial, compensating for the detrimental effects [15]. Further, the feedback delays were constant (i.e. systematic) within the block. Humans are particularly sensitive to unsystematic deviations [9, 10] but only in the test phase as well as in Experiment 1 different feedback delays were randomly presented.

4 General Discussion

Two experiments examined processes that are affected by visual feedback delays and potential compensatory mechanisms during a complex motor task revealing the following results. First, delayed feedback led to longer durations for task completion and diminished accuracy slightly. Overall, 200 ms delays worsened performance, which underpins the need to formulate requirements on the speed and reliability of visual feedback for fine-motor skill performance during human-CPS interaction.

Second, feedback delays were associated with an increased frequency of corrective hand movements (i.e. intermittencies) and this frequency was highly correlated with task performance. Earlier evidence on the impact of feedback delays on intermittencies is conflicting. An increase might reflect a strategy mainly based on feedforward processes in human motor control neglecting visual feedback [11]. However, for the used complex motor task, the findings rather indicate a strategy geared to a slowing of the movement process to keep control [12]. By using augmented feedback on movement kinematic, future work could induce strategies to improve performance under delayed feedback. In this context, expertise could play an important role as well.

Third, adaptation after short exposure to a specific delay was, if any, limited to this delay length pointing out chances and limits regarding human adaptation to feedback

delays. Different settings need to be tested (e.g., longer exposure time, use of random delays) and long-term effects evaluated. Beyond that, using VR setups would allow comparing adaptation processes for different visualizations (e.g., 2D and 3D scenes) or for varying degrees of congruency between multisensory information (e.g., delayed visual and haptic information). Together, this kind of research brings us closer to the vision of implementing innovative technology for sharing expertise around the world.

Acknowledgements. We thank Anna Marie Kühn and Marlen Krüger for helping with the data acquisition. This work has been funded by the German Research Foundation (DFG, Deutsche Forschungsgemeinschaft) as part of Germany's Excellence Strategy – EXC 2050/1 – Project ID 390696704 – Cluster of Excellence "Centre for Tactile Internet with Human-in-the-Loop" (CeTI) of Technische Universität Dresden.

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Design for Forest Fire Environments: Numerical Tree and Fireman Thermal Response for Nearby Forest Fire Environments

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Abstract. This article presents a numerical study where the thermal responses of a tree and a fireman are compared, both inserted in a forest fire environment. The three-dimensional pine tree model is constituted by 1039 cylindrical elements to represent its trunk, branches and leaves. The human body model is divided into 35 elements. Each element is subdivided into several layers, constituted by fat, muscle, core and skin, and can be shielded from the outside environment by several clothing layers. The tree and fireman thermal response numerical models are based on energy and mass balance integral equations. In the last one the thermoregulatory system is also considered. Both systems consider the phenomena of conduction, convection, transpiration and radiation. The tree and the fireman are placed nearby the fire front, which represents the forest fire. The surface temperature of both bodies is analyzed on a steady-state and transient regime.

Keywords: Fireman thermoregulatory response · Forest fire · Numerical models · Tree thermal response

1 Introduction

Trees are vascular plants, just as humans are vascular animals. Vascular beings need vessels, which are nothing more than biological pipes (phloem and xylem, in plants; arteries and veins, in animals), through which water and liquid (sap in plants and blood in animals) circulate, which they carry nutrients for the whole body of the living being.

The forest occupies about 39% of the Portuguese mainland, totaling 3.2 million hectares [1]. Portugal is also the country with the largest number of annual forest fires in whole Europa [1, 2], where it is customary to have years with reports of occurrences of more than 20,000 annual fires [3]. These occurrences lead to an increased strain on the fire brigades throughout the dry season, which normally lasts for about 5 months.

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 1147–1154, 2022.
https://doi.org/10.1007/978-3-030-85540-6_147

The tree numerical model developed in this work is based on the numerical model used to simulate the human body geometry. The human body geometry numerical model was introduced into the numerical model of human body thermal response. Its application can be seen in the studies of Conceição and Lúcio [4], and Conceição et al. [5, 6].

In the tree and fireman thermal response, it is important to consider the radiative heat exchanges to evaluate the thermal interaction between the tree and fireman body surfaces and the surrounding surfaces (with emphasis on the fire front). It is also relevant to consider the convective heat exchanges between the body surface and the surrounding airflow, the heat conduction through the bodies' tissues, water heat loss by evaporation from the tree to the environment and transpired water in the skin surface and clothing of the fireman. Both numerical models use energy and mass balance equations to simulate these phenomena. Mesh generation is used by both numerical models to establish the energy balance equations. The radiative heat exchanges between people and surrounding radiant surfaces was studied in the work of Conceição and Lúcio [7]. Radiative and convective exchanges in the human body are evaluated in the work of Conceição et al. [6]. Studies about airflow around people can be found in Conceição et al. [8, 9]. The use of mesh generation in the radiative heat exchanges was applied in the works of Conceição and Lúcio [10–12], and Conceição et al. [13–15].

Knowing the thermal behavior of a tree and a properly equipped firefighter in the presence of a forest fire is essential to define tree protection strategies (for example, by cleaning the vegetation cover) and the suitability of the firefighters' clothing to the conditions of a warm environment. It is therefore necessary to develop both geometric models and transient and steady-state thermal behavior models that adequately represent the thermal response of the tree and the fireman. Consequently, it is possible to adapt the geometric model and the systems of energy and mass balance equations of the human body to those of the tree. This work aims to establish and refine these models so that the thermal response of these bodies to a forest fire can be more accurately known. In this sense, the distribution of surface temperatures in the various elements of the tree and the fireman's body are obtained numerically, either in a steady-state or in a transient regime.

2 Models and Materials

The representation of the trunks, branches and leaves of the tree is done by the three-dimensional tree model that is built from cylindrical elements (Fig. 1a). In turn, each of these elements, dimensioned by their diameter and length, is subdivided into layers. This geometric model will be used as an input by the numerical model of the tree thermal response. The human body geometric model, shown in Fig. 1b, is built from 34 cylindrical elements (representing the abdomen, shoulders, arms, hands, thighs, legs and feet) and 1 spherical element (representing the head). Each element is subdivided into layers (fat, muscle, core and skin), being protected from the surrounding environment by several layers of clothing. This geometric model will be used as an input by the numerical model of the human thermal response.

The numerical model of the human thermal response, which also takes into account its thermoregulation, was used to assess the steady-state and transit thermal response of the fireman situated in a forest fire environment. The numerical model of the tree thermal

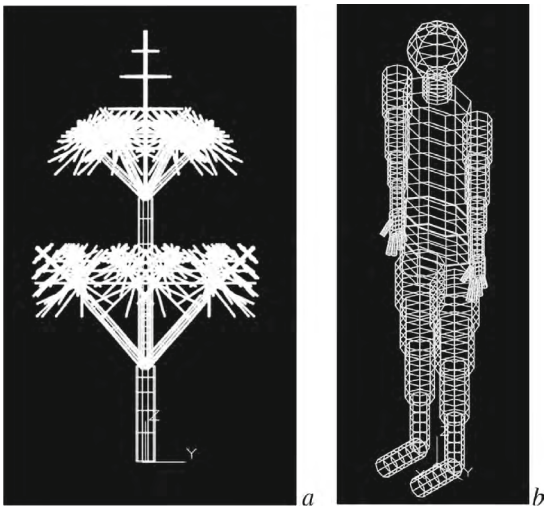


Fig. 1. Three-dimensional models: *a)* tree; *b)* human body (fireman).

response was based on the numerical model of human thermal comfort, except for the thermoregulatory system, considering a new geometry and new water circulation paths. It was used to assess the steady-state and transit thermal response of the tree situated in a forest fire environment. The numerical model of human thermal comfort was validated in the work of Conceição et al. [4]. For example, it was applied in studies characterized by environments influenced by solar radiation and radiant surfaces [7, 16].

Both thermal response models consider the following phenomena: radiation; conduction; convection; and evaporation. The conduction phenomenon appears between the various layers of each body element. The convection and evaporation phenomena appear between the bodies external surface and the surrounding air environment. The radiation phenomenon appears between the bodies external surface and the fire front, whose modeling uses the Mean Radiant Temperature (MRT) values. The numerical model of tree thermal response is based on the energy balance integral equations for the tree body tissues and the mass balance integral equation for the water in the tree. The numerical model of human thermal response is based on the energy balance integral equations for the body tissues, blood and clothing as well as mass balance integral equations for the blood and transpired water in the skin surface and clothing. The systems of equations defined above are solved by the Runge-Kutta-Fehlberg algorithm with error control.

The virtual tree model has a height of 1.8 m. It consists of 1039 cylindrical elements (14 trunks, 25 branches and 1000 leaves), distributed over two levels, each with 7 trunks, 12 branches and 40 leaves per branch, and at the top a branch with 40 leaves. The virtual fireman (human body) model has a height of 1.8 m and consists of 35 elements. It is equipped with three layers of clothing, the outer layer corresponding to the typical equipment (including the helmet) of a fireman fighting a forest fire. The fire front is 10 m wide and 1 m high, being static in the numerical simulation. In the respective numerical simulation, the tree or the fireman is placed at a distance of 5 m perpendicular to the central zone of the fire front, as shown, respectively, in Fig. 2 and Fig. 3.

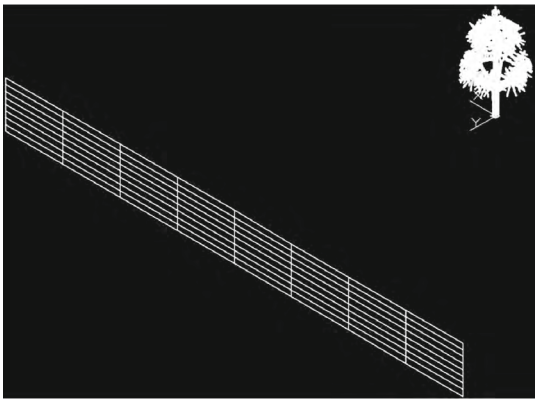


Fig. 2. Location of the tree in relation to the fire front.

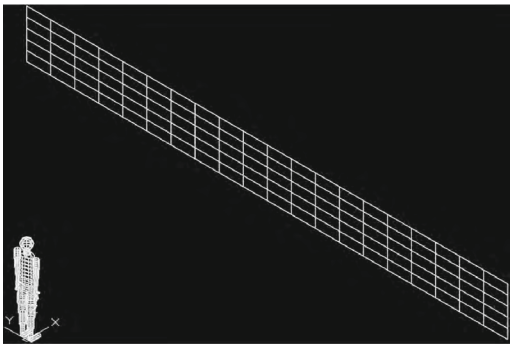


Fig. 3. Location of the fireman in relation to the fire front.

The numerical simulations have, as input data, a flame mean temperature of 500 ºC, an environmental air temperature of 20 ºC, an environmental air relative humidity of 50%, and a wind speed of 5 m/s. As output data, there is the surface temperature distribution in the tree and in the fireman in steady-state and in a transient regime obtained during a time interval of 1000 s.

3 Results and Discussion

This section presents the results obtained from the MRT distribution (Fig. 4) and the surface temperature (Fig. 5) in several elements of the tree. Also presented are the results obtained from the MRT distribution (Fig. 6) and the surface temperature (Fig. 7) in different sections of the fireman's body.

The results show that the tree's MRT varies between 70.7 ºC and 112.1 ºC. The highest values are obtained in the most exposed branches and leaves facing the fire front and the lowest in the innermost branches and leaves of the tree located opposite the fire front. Surface temperatures stabilize more quickly on leaves (after about 600 s) than on

trunks and branches (above 1000 s). The surface temperatures on the leaves stabilize between 42.5 ºC and 67 ºC. The highest values are obtained on the outermost leaves and the lowest values are obtained on the innermost leaves of the branches. It is also verified that the ranges of surface temperatures in the leaves are in accordance with the distribution of the leaves in 4 levels (of 10 leaves each) per branch.

The MRT in the fireman's body varies between 168 ºC in the feet area and 290 ºC in the abdomen area. However, most sections of the fireman's body have an MRT between 265 ºC and 290 ºC which denotes their great exposure to fire front. The steady-state skin surface temperatures in the fireman vary between 31.3 ºC in the hands and feet and 38.5 ºC in the upper section of the abdomen. It is thus verified that the skin surface temperatures in the different sections of the fireman's body are within the safety values, which shows that the equipment used provides adequate protection. The stabilization of the skin surface temperature in the different sections of the fireman's body occurs after about 600 s. It verifies that, after stabilization, the average skin surface temperature is 36.0 ºC.

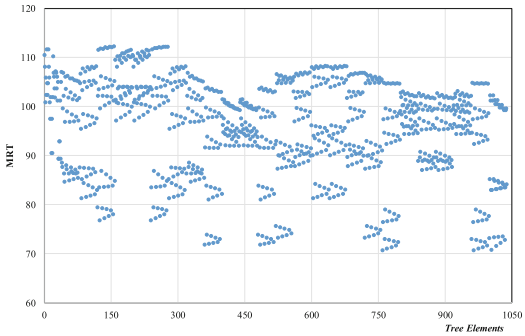


Fig. 4. MRT distribution in the 1039 elements of the tree.

The MRT distribution values on the elements of the tree are lower than those on the sections of the fireman's body, because the fireman has a greater area of exposure to fire front.

The surface temperature of the elements of the tree are much higher than the skin surface temperature of the fireman. This is justified by the thermoregulation and clothing systems of the fireman that allow him to control the skin temperature. In the case of the tree, its evaporation process is not effective enough to control the temperature.

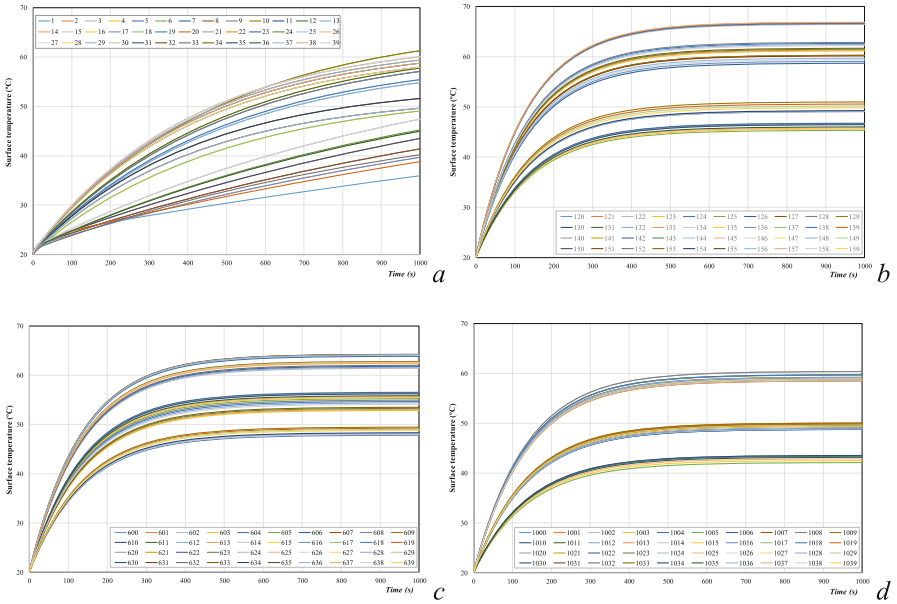


Fig. 5. Surface temperature in the following elements of the tree: *a)* trunks and branches (1–39); *b)* leaves (120–159), branch near the ground; *c)* leaves (600–630), branch near the top; *d)* leaves (1000–1039), branch on the top.

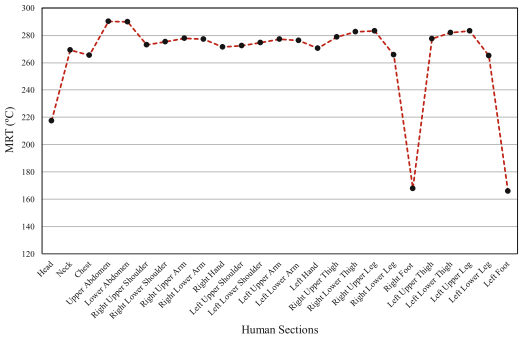


Fig. 6. MRT distribution in the fireman.

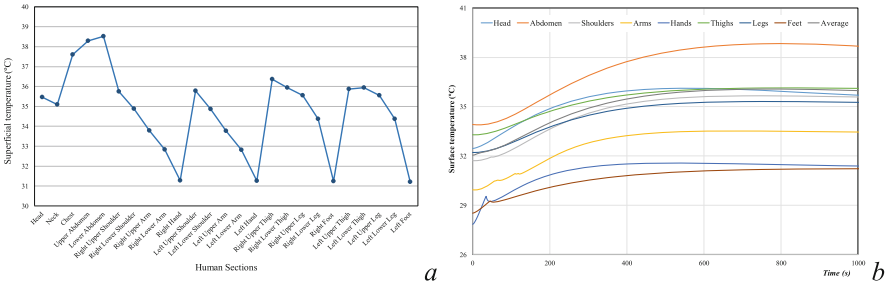


Fig. 7. Skin surface temperature of the fireman: *a)* steady-state conditions; *b)* transient conditions.

4 Conclusions

In this paper a numerical study was presented on the thermal response of a tree and a fireman, both with the same height, when subjected to the action of a forest fire, represented here by a fire front. The main conclusions are:

- The highest values of the MRT distribution in the tree are obtained in the most exposed branches and leaves facing the fire front, while in the fireman they are obtained in the abdomen area;
- The temperatures on the surface of the tree elements and on the fireman's skin surface tend to stabilize at about the same time;
- Due to the human thermoregulatory and clothing systems, the skin surface temperature of the fireman is much lower than the surface temperature in the elements (trunk, branches and leaves) of the tree.

Acknowledgments. The authors would like to acknowledge the support of the project reference PCIF/MPG/0108/2017, funded by the Portuguese Foundation of Science and Technology (FCT).

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Resource Management Model to Reduce Maintenance Service Times for SMEs in Lima-Peru

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Abstract. Currently, companies engaged in maintenance and repair work are being affected due to the gradual increase in delays in their services. Consequently, an important economic impact has been generated in the sector, which is reflected in a 21% increase in its operating costs. After reviewing the literature, little information was found about the sector, due to which, the motivation is to carry out the study of a service SME in Lima, Peru. The proposed solution model comprises four phases: in the first phase, change management is developed, in the second phase, a study of the work is carried out, in the third phase, inventory management is applied, and in the last phase, they are standardized. The procedures previously developed. Based on this, it is possible to reduce costs by up to 12%, as well as reducing the number of delays by 15%.

Keywords: SMEs · Services · Inventories · Procedure standardization · Integrated model · Work study · Peru

1 Introduction

As a result of a competitive environment, SMEs have the need to efficiently meet the demand imposed by the market, whether it is a company dedicated to the transformation of raw materials or one that provides services [1]. In the case of service companies, in order to improve their competitiveness and growth, they focus their attention solely on increasing their client portfolio despite the fact that, in the absence of proper management, this causes an increase in the rates of delays in the delivery of their services. One of the sectors that is most affected are companies that perform maintenance and repair services since, according to [2–4] in countries such as Italy, Portugal and Spain, their delay rates range from 10.75% and 22.43%. On the other hand, in Peru, according to the INEI, 53% of the companies in the same category have 30.35% of complaints due to non-compliance with the established delivery deadlines.

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 1155–1163, 2022.
https://doi.org/10.1007/978-3-030-85540-6_148

The research focuses on a services SME located in Lima-Peru, where according to [5] they represent 75% of the national GDP, therefore, they are called the main drivers of the country's economic growth. For this reason, we consider the main motivation to carry out a diagnosis of the current situation of the company with the intention of presenting improvement plans that achieve transcending in the sector.

An inventory management model for the materials necessary to carry out maintenance activities is proposed as a solution, together with a work study for the efficient distribution of the workload assigned to each operator. Likewise, the main contribution is based on developing a change management stage to sensitize companies about the importance of achieving better administrative performance by adopting new attitudes and behaviors. Additionally, it is proposed to standardize the necessary procedures that will solve the problem with the intention of guaranteeing sustainability over time.

2 Literature Review

2.1 Change Management

Organizations have been involved in changes caused by the competitive market generating new approaches to carry out their processes in such a way that, can expand their market, become more flexible and productive [6]. That is why change management is understood as the transition process that occurs within people as a result of change, which involves a series of efforts in order to generate achievements or improvements in the organization. In this way, it is possible to affirm that "change is a natural process which will have results with or without the methodology to carry it out" [7, 8].

2.2 Lewin's Change Method

Lewin's method of change is divided into three stages, which allow us to identify the essential factors for change. This model had not been intended for third sector companies, due to little evidence. However, according to [7], the organizations within this sector can successfully respond to change needs by implementing Lewin's method.

Thawing. In this stage of the method, the analysis of the force fields is carried out since, it is necessary to understand the current situation of the environment to be analyzed, it aims to reach an understanding between the need and the importance of change. In this phase, the people who will be involved with this process are prepared in order to get out of their comfort zone [7]. This preparation process can be carried out through the participation of collaborators actively in awareness sessions since, that is where the pros and cons that will accompany the process are analyzed [7].

Change. In this second part of the method is when the necessary changes are made in the organization. Thus, people being already "unlocked" move towards a new way of being. This stage is not an easy process since the collaborators are in a process of learning from changes, it is for them that it is vital to establish deadlines so that they can understand the changes, adopt them and make them part of their new work routine [7].

Re-freezing. This stage seeks to create stability once the changes have been made. This phase implies the establishment of a process that aims to take care of the new level of behavior which is not affected by external factors that lead as a consequence to a new change, since in this stage it is sought that the changes are accepted and convert formal organizations into standards [7].

2.3 Inventory Management

Inventory management is essential to satisfy market demand. Likewise, the lack of control can affect the delivery times of products or services, their availability, operating costs, and company profits, among others [9]. According to [10] inventory management systems are generally based on recognized inventory concepts, models and techniques. Among the main techniques used by SMEs is the ABC Analysis, which divides the inventory into three groups according to the volume of annual consumption and its cost, therefore, it is considered the most appropriate for long-term decision making [11]. Likewise, another commonly used technique is the Economic Order Quantity (EOQ), which minimizes the sum of two conflicting inventory costs: order and maintenance costs [12]. As part of inventory management is to maintain adequate stock levels to avoid stock breakages, it is important to have knowledge of the historical data of the consumption of the items in the warehouse and the delivery time [13].

2.4 Proposed Model

To guarantee the success of the companies and the reduction of their costs, a good planning both at the inventory and labor levels must be fundamental for the organizations, regardless of the size or the sector to which they belong [7]. After reviewing the literature, various business sectors were identified where they apply concepts for inventory management and human resources administration, however the information is scarce for the service sector despite having a significant percentage of participation in the economy of the countries. For this reason, we believe it is convenient to carry out the research based on a company belonging to this area with the intention of raising awareness and motivating organizations about the adoption of methodologies to improve the distribution and management of their resources. The present model is made up of three phases, including a zero phase (Fig. 1).

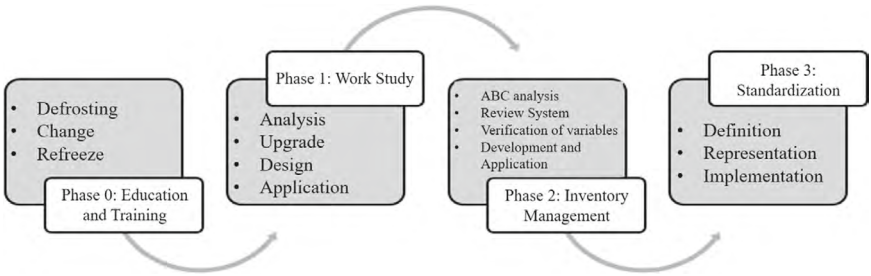


Fig. 1. Proposed model

2.5 Detail of the Model

Phase 0: Education and Training. To initiate a phase of change, all the factors that have a close influence on the change must be taken into account. For which it is very important to bear in mind that a change process will include all the collaborators of an organization.

Defrosting. In this first component, the force fields (driving and impeding) are analyzed in order to know the current situation of the environment to be analyzed. In other words, prepare the organization to accept that change is necessary, in order to reduce resistance to change by making staff recognize the need to change the current state.

Change. In this component, the organization will go through a stage of uncertainty as a result of the unfreezing, convincing the people involved that the new ways of working, thoughts, emotions, etc., are better than the previous ones.

Refreeze. Once change has been established in the organization and people commit to new ways of working, then the refreeze can proceed. This stage represents the total integration of the new knowledge learned.

Phase 1: Work Study
Analysis. This phase begins with the analysis of the current measurement methodology of the company. This component shows the absence of qualitative and quantitative criteria to carry out a correct assignment of personnel.

Measurement Process Update. This component includes new valuation factors to take into account to calculate the workload. The factors to be taken into account were: Assessment of the activities, which will make it possible to determine the importance and rigor they require at the time of being executed; Task execution criteria, which can analyze and improve the work execution process.

Instructional Design. The completion of instructions will allow the correct application of a new method of measuring workload, since in this way it can be maintained in a long-term period.

Application of the New Measurement Procedure. This component includes new valuation factors to take into account to calculate the workload. The factors to be considered were: Assessment of the activities, which will allow to determine the importance and rigor they require at the time of being executed and Criteria for the execution of the task, which will analyze and improve the work execution process. Likewise, the design of the necessary instructions is carried out that will allow the correct application of a new method of measuring workload, since in this way it can be maintained in a long-term period.

Phase 2: Inventory Management. In this phase, a quantitative analysis of the materials needed to carry out the maintenance services was carried out. It is important that the company has a record of the type of material used, the sources used for each service, the supply time and the acquisition cost. This phase is subdivided into:

ABC Analysis. In the first place, the materials were registered and then the corresponding classification was made according to the volume of consumption and the purchase price of each material.

Review System. Once the materials with classification A, B and C have been identified, the type of revision system will be determined for each group. Materials that are in group A with a continuous review system should be considered as they are the most relevant for the company. While the articles that are in group B and C correspond to a periodic review system.

Variable Verification. Before performing the calculations to determine inventory policies, it must be verified that both the demand for the items and the supply time follow a normal distribution in addition to verifying if there is a correlation between them. To calculate the replacement point, the equation to be used varies according to the degree of correlation between demand and supply time, since this difference significantly affects the value obtained by each equation.

Development and Application. After determining the correlation between the variables, the calculation is carried out to determine the inventory policies according to the corresponding review system for each ABC classification group.

Phase 3: Standardization. This phase aims to make the proposed design transcend and have durability over time by unifying the procedures that must be carried out regarding the assignment of personnel and the replacement of materials, both essential resources for the development of a company. To carry out this phase, the following stages will be developed:

Definition. First, the procedures to be standardized were defined by identifying the objectives, the person responsible for carrying out the procedures, as well as the input resources and the results obtained.

Representation. After the definition of the standards, the representation was made by means of luxury diagrams of the procedures carried out in Phase 1 and 2 of the model. The visual representation of the established procedures facilitates understanding and provides an overview of the flow of information produced to carry out an activity [7].

Implementation. For the implementation of standardized procedures, what has been done previously is consolidated in a procedures manual for both inventory management and the personnel assignment process.

3 Validation

3.1 Initial Diagnosis

The company is study is a national company founded in 2017 dedicated to the development of Projects, Services, Manufacturing and Marketing of equipment for the treatment of Energy and its problems of air conditioning, electronic security systems and against fire. The company has 34 workers who work a total of 8 h a day. In addition, technical operators work shifts during the night. Of the total services provided by the company, 80% are dedicated to UPS equipment maintenance services.

3.2 Commissioning

To carry out the validation process, the process of carrying out preventive maintenance was taken into account from the entry of the service order until the completion of the service execution.

Analysis of Input Data. We proceeded to obtain the data of each of the processes to be carried out. The minimum number of samples and the distribution of the times obtained through the Input Analyzer are detailed. The work was carried out with a confidence level of 95%.

Development of the Current Situation. The Arena program was used to determine the time that the system decreases after the proposed model was implemented.

Data to take into account for the development of the simulator:

- The working day to take into account is 8 h, without considering snacks or stops during the process.
- Each of the workstations has a single queue.
- In order to carry out the economic analysis, the Assing and Record processes were used in order to obtain a final report.
- We started with 15 replications, which is the minimum to start the test.

Once the results of the Output Analyzer have been obtained, the current simulation is carried out with the aforementioned data.

Description of the information obtained:

- Cycle time: it is defined by the time in the service order system provided by the sand report.
- Employee utilization: Obtained with the value of "TECNICO1.Utilization" of the services provided by the sand report.
- Number of operators: it is obtained from the amount of resources assigned to each workstation for the services provided by the sand report.

Next, the summary table with the data obtained in the arena program will be shown (Table 1):

Table 1. Current situation

Parameters	Current situation
Cycle time of service orders	4.88 h
Operators utilization percentage	92%
Number of empirically assigned operators	2

Development of the Improvement Situation. After the implementation of the solution proposal, the simulation of the improvement situation in the Arena program was developed. For the improvement situation, a confidence level of 95% was taken into account.

Description of the information obtained:

- Cycle time: it is defined by the time in the service order system provided by the sand report.
- Employee utilization: Obtained with the value of "TECNICO1.Utilization" of the services provided by the sand report.
- Number of operators: it is obtained from the amount of resources assigned to each workstation for the services provided by the sand report.

Next, the summary table with the data obtained in the arena program will be shown (Table 2):

Table 2. Improvement situation

Parameters	Improvement situation
Cycle time of service orders	4.41 h
Operators utilization percentage	81.97%
Number of empirically assigned operators	3

Comparison of the Current Situation with the Improvement Situation. Once both simulations (current and improvement) had been carried out, the following comparison was made (Table 3).

Table 3. Comparation

	Current situation	Improvement situation
TSYSTEM	4.8882	4.414
TECHNICIAN 1. Utilization	92.63%	79.85%
TECHNICIANS	2	3

From the previous table, it can be concluded that the improvement situation managed to reduce the time of the service order in the system, it is also evident that after having implemented a correct assignment of personnel, the utilization and the cycle time decreases by 0.47 h.

4 Conclusions

With the help of the Arena simulator, it was possible to show that the cycle time of the current situation of the company was 4.88 h, compared to the analysis of the improvement situation after having applied the improvement tools, it was reduced to 4.41 h of cycle time in the system, achieving a 9.6% reduction in cycle time.

It is possible to verify that the personnel assignment method currently used by the company causes the personnel to have a utilization percentage above the permitted limit (85%) which is 92.63%; However, after applying the corresponding work study for a correct assignment of personnel, the level of use of technical personnel decreases to 79.85%.

It is concluded that the implementation project could generate an approximate saving of 116,595 soles for the company during the first year.

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Occupational Psychosocial Risks Identification and Assessment in the Czech Republic

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Abstract. Psychosocial risks in the workplace result from the nature and organization of work, interpersonal relationships in the workplace and the balance of work and family life. We decided to conduct the research project to identify and assess the psychosocial risks in the sector of postal services in the Czech Republic. In cooperation with trade unions a special questionnaire with 25 items was prepared and administered to employees of the postal services in the Czech Republic from February to November 2020. To date, a preliminary analysis of 648 questionnaires was made. These results show some signs of the psychosocial work-related risks (verbal violence from clients, dissatisfaction with financial evaluation, shift work and poor quality and quantity of sleep) but also some positive findings (interesting work, use of skills, sufficient managerial appreciation, good health protection).

Keywords: Occupational psychosocial risks · Assessment · Postal service

1 Introduction

Psychosocial risks in the workplace result from the nature and organization of work, interpersonal relationships in the workplace and the balance of work and family life [1]. If these risks are perceived by employees as exceeding their capacity to tolerate them, they can be a source of work stress. Its influence can have a negative effect on both the mental and physical health of employees, which can fundamentally affect the operation of the entire company. According to latest findings from the European Survey of Enterprises on New and Emerging Risks [2] are the European workplaces most concerned about musculoskeletal disorders and psychosocial risks. Psychosocial risk factors are most frequently reported in service sectors [2]. European Working Condition Survey [3] states that psychosocial risks at work are becoming increasingly important, mainly due

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 1164–1170, 2022.
https://doi.org/10.1007/978-3-030-85540-6_149

to growing emotional demands, while the social support from superiors and coworkers remains at the same level [3]. The most vulnerable sectors are health and education, together with public administration and the transport sector. In healthcare, up to 20% of employees complain of verbal abuse, in public administration 11% of employees have experienced threats in their work [4]. Some of the psychosocial work-related risks (effort-reward imbalance, low organizational justice and high job demands) are associated with the largest increased risk of stress-related mental disorders in varying degree from 60% to 90% [5]. Depressive and anxiety disorders have a significant economic impact, with estimated productivity losses of up to $ 1 trillion per year worldwide [6]. In the Czech Republic, work stress is perceived by 49% of employees, almost 7% have manifestations of clinically severe depression and up to 30% of the work population have mild symptoms of depressive disorders [7]. Since 2012 the National Institute of Public Health in Prague has been monitoring the level of psychosocial risks at the workplace through anonymous questionnaire surveys among employees in various professions [8]. The current research project is focused on identification and assessment of the psychosocial risks in the sector of postal services in the Czech Republic and perception of psychosocial risks in employees with disabilities. The project "Management of psychosocial risks for practice for employees with disabilities" is financed by the Technology Agency of the Czech Republic within the ÉTA Program and research is also supported by the Ministry of Health of the Czech Republic - RVO (National Institute of Public Health - NIPH, 75010330).

For a number of years now, postal services have been going through enormous changes in organization and structure. Position of a postal office clerk is very demanding: in addition to the classic postal services, the worker must also offer and explain lot of financial products to clients, must be able to provide them with a great amount of information. He/she also bears financial responsibility, communicates with customers, fulfills the plan and high demands of management. The postal sector also includes positions outside the counters, such as postal delivery men, mail and package sorters, technical, administrative and managerial positions. Unlike other professions where psychosocial risks and work-related stress were already repeatedly studied, such as nurses, doctors, teachers, etc., the postal sector is not an area that many researchers would focus on. Studies in similar professions (e.g. banking sector) show that workplace stress is a critical issue with potentially negative effects on workers´ and organizations´ psychological and physical health. Most of the studies showed increase in mental health problems closely related to stress at work [9].

People with disabilities have a more complicated access to finding a job, and it is often more difficult for them to do so. Their disability limits them in their work performance and in their choice of occupation, and it is also a source of a number of problems outside the workplace, which in turn affect their work performance. For this reason, they experience some additional psychosocial risks and stresses, which do not apply to employees without disabilities. Also in this group of employees (as in postal service workers) is very insufficient data available about psychosocial risks at work. More is known about the staff providing care to people with disabilities. Staff caring for people with intellectual disabilities is at an increased risk of burnout. Results suggest that depression symptoms and low organizational support frequently correlate with burnout

symptoms. Furthermore, support from coworkers and from organization may help their sense of personal accomplishment, and buffer against emotional exhaustion [10].

2 Materials and Methods

In cooperation with trade unions a special questionnaire with 25 items was prepared and administered to employees of the postal services in the Czech Republic from February to November 2020. The questionnaire was administered during personal visit at the workplace by the trade union representative.

2.1 Participants and Procedure

The study population included postal office workers from one postal service company in the Czech Republic. During the regular visit from trade union representative at the workplace the aim of the investigation was explained and employees were asked to fill out a self-report questionnaire. Between February and November 2020, 692 workers completed the questionnaires on a voluntary basis. Of these 44 (6.4%) questionnaires were excluded for missing data. The final number of respondents is 648. The study group included 568 females (88%) and 80 men (12%). The biggest age group was 30 to 49 years of age (51%, 328 respondents), then followed 50 to 64 years of age (29%, 186 respondents), and employees younger than 29 years of age taken 19% (124 respondents); only 10 respondents (2%) were over 65 years of age. Most of the participants had secondary education (92%, 598 respondents), university education had 5%, 34 respondents, only primary education had 16 respondents (2%). Positions of postal office counter workers maintained 33.49%, 217 respondents, postal delivery men accounted for 28.85%, 187 respondents, and managerial made up 8.95%, 58 respondents. The rest of respondents were working in other positions (mail and package sorters, technical, administrative, etc.).

2.2 Tools

The questionnaire with 25 items included questions on demographic and occupational characteristics (age group, gender, education, job position, region of workplace), psychosocial working conditions (yes-no responses), and sleep characteristics (number of hours, sufficient length) and was completed in writing at the workplace.

2.3 Data Analysis

Preliminary results were described by the percentage of responses using Microsoft Excel spreadsheet software.

3 Results

The preliminary results show that less than half of the employees (45%, 294 employees) is using their qualifications at work, but majority of the employees (79%, 513) is using their skills. Almost the same proportion of respondents (71%, 462) agree that they have independent job control, and vast majority (88%, 571) of respondents agree that their work is interesting. With fair financial evaluation of their work agree less than half of the respondents (42%, 273), but more employees feel sufficient appreciation from managers – 67.7%, 439 respondents. With adequate health protection at the workplace agree 73%, 474 employees. These results are presented in Fig. 1.

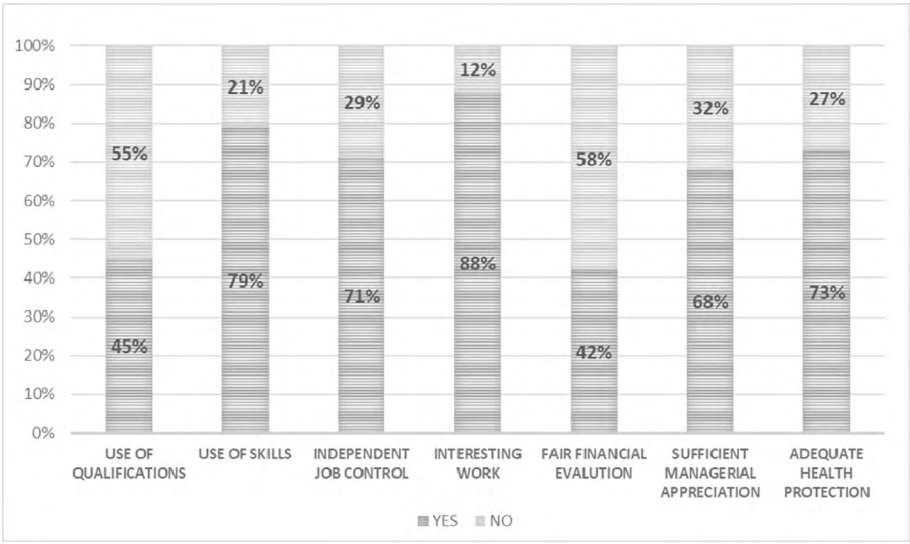


Fig. 1. Psychosocial work-related risks (use of qualifications and skills, job control, evaluation, appreciation, health protection)

In Fig. 2 are showed the answers to the occurrence of negative social behavior in the workplace. Bullying from superiors reported 3%, 17 employees, bullying from coworkers 1%, 8 employees, but bullying from clients reported 8%, 51 employees. Worrying results showed answers to the question on verbal abuse. Verbal violence from clients was reported in 19%, 125 of answers and almost none from either superiors or coworkers (1%, 8). Physical violence was reported in minimum cases as well (2.8% from clients, 0.3% from coworkers and 0% from superiors).

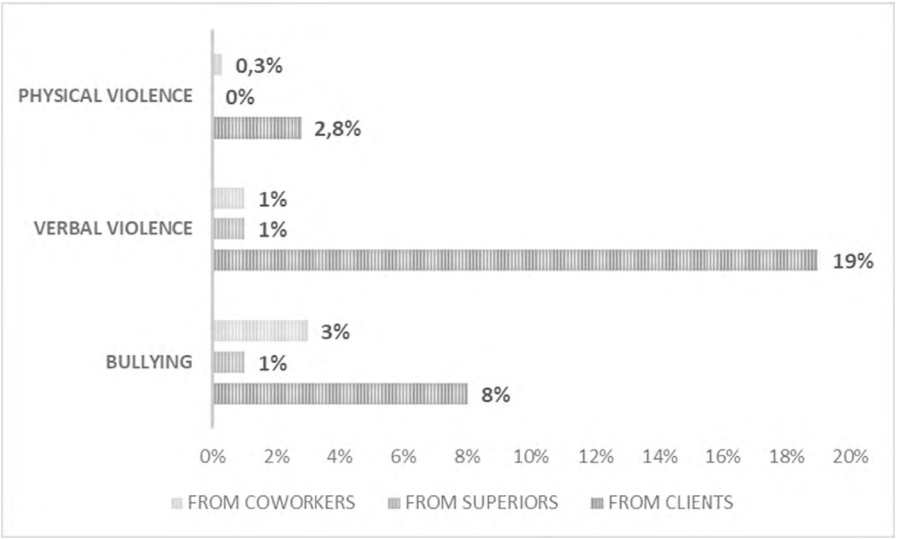


Fig. 2. Negative social behavior (physical and verbal violence, bullying)

Figure 3 shows results from questions connected to sleep and shift work characteristics. Every second employee of the postal services who filled the questionnaire is working in shift pattern (49%, 317), but only 12% of respondents are working during night hours. We learned that only little more than half of the respondents (54%, 347) feel that they get adequate amount of sleep and even more than third (33%, 212) reported having some sleep disorders. Quantity of sleep was also evaluated. The average number of hours spent sleeping was 6.5, with 50% of employees sleeping 6 h or less, and 56% of employees who sleep 6 h per night consider this amount of sleep insufficient.

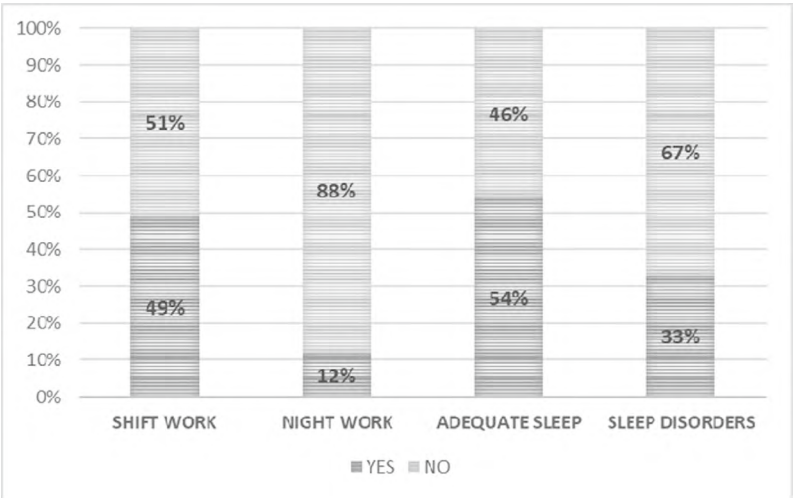


Fig. 3. Shift work and sleep characteristics

We also asked about work-life balance and only 54%, 350 of respondents reported having enough time for their family and friends. We expect further results in the near future.

4 Discussion

The preliminary results of our study show that even if the employees in postal services are not using fully their qualifications they can still use their skills and perceive their work as very interesting. They also feel that their health at workplace is protected enough but they are definitely not satisfied with fair financial evaluation. Positive finding is that managerial appreciation of their work is felt as sufficient by more employees (1.6 times) than a financial evaluation which means good social policy and corresponding managerial skills. Our results also show that number of employees complaining of verbal abuse in post office sector is on the same level as for example in healthcare [4]. This could mean that dealing with clients at the post office is as demanding and complicated as dealing with patients. Reported poor quality and quantity of sleep is a very important warning sign of possible health problems.

5 Conclusion

Psychosocial risks in the workplace result from the nature and organization of work, interpersonal relationships in the workplace and the balance of work and family life. For a number of years now, postal services have been going through enormous changes in organization and structure but very little is known about their psychosocial risks at work. Our preliminary results show some signs of the psychosocial work-related risks (verbal violence from clients, dissatisfaction with financial evaluation, shift work and poor quality and quantity of sleep) but also some positive findings (interesting work, use of skills, sufficient managerial evaluation, good health protection). In the next phase a thorough statistical evaluation of the whole study will be done with an introduction of preventive intervention measures.

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Movement Coordination: Let's Take a Step Forward to Make Our Life Enjoyable

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Abstract. This paper points out that we have devoted too much time and efforts in the artificial world, and we have forgotten the natural world. But the Real World comes to change frequently, extensively, and unpredictably. Therefore, to cope with this Real World, we need to perceive it correctly and make adequate decisions. We need to work together with machines on the same team. To achieve this goal, we need to introduce nonverbal approach and movement plays an important role. It is a nonverbal communication tool and enable us to be intelligent in the original sense.

Keywords: Intelligence · Perception · Movement · Instinct · Human Machine Integration · Ordinal

1 Introduction

Our World changes from one to another as one world gets to its ceiling, as described in the next chapter. We call the world after the Industrial Revolution "World 2.0" here.

World 2.0 is an industrial society. But World 2.0 is getting close to its ceiling and many issues are emerging such as decreasing childbirth, quickly aging society, depletion of energy resources. Therefore, we need to consider what the next world will be and how we can develop it.

This paper points out that we have been too much focused on artificial world, and we paid all our efforts to push forward technologies. But as the Real World is changing frequently, extensively and in an unpredictably manner. So, we need to directly interact with the Real World. Interestingly enough, the octopus teaches us what world would make us flexible and adaptive to cope with this drastically changing world.

In short, we have been too much stuck with technologies. Our world has been an artificial world. But if we look back to World 1.0, when we were developing everything by ourselves, or in other words, when we worked for ourselves, we will understand that if we turn our eyes to self-sustaining, i.e., if we work for ourselves, we can enjoy the process and we can have a mental satisfaction or the feeling of achievement. In engineering and economics, we have been focusing on mass, product, and rational approaches. Utility is external. But if we come to work for ourselves, we can self-sustain ourselves by working for ourselves, or for internal rewards, then many issues will be solved and everybody, young and old, enjoy his or her life.

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 1171–1177, 2022.
https://doi.org/10.1007/978-3-030-85540-6_150

2 World Changes from One to Another: S Growth Curve

As Fig. 1 shows, our world changes from one to another,

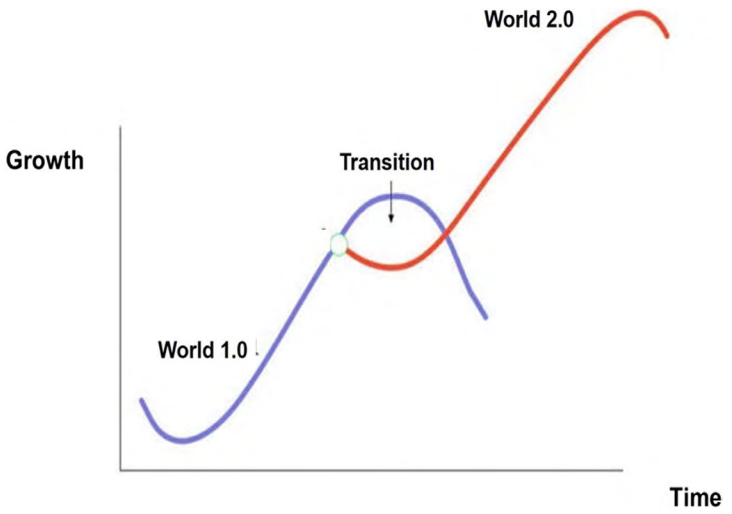


Fig. 1. S-growth curve.

3 The Real World is Changing Rapidly

3.1 Closed World with Boundary to Open World with Boundary

Up to now, our world has been closed with boundary. So, it is straight forward to apply mathematical approaches. And although our world is expanding rapidly, and changes come to occur frequently and extensively, we developed System Identification approach and succeeded in maintaining the current framework of engineering. The basic idea of this approach is the same as that of identifying the name of a river. If we look at the river itself, we cannot, because flow is changing every minute. But if we look around, we can find mountains, forests, etc. that do not change. So, we can identify the name of a river. In other words, they serve as parameters. But not only world is expanding rapidly, but changes themselves come to change.

3.2 Changes Are Changing

Changes yesterday changed smoothly, so we could differentiate them and predict the future. So, engineers can foresee the operating conditions of their products and control them. But today, they change very sharply. Therefore, we cannot differentiate them. We cannot predict the future anymore.

3.3 Human Needs Are Changing

Maslow made it clear by his hierarchy of human needs that our needs start from material and change toward mental, and at the top of the hierarchy, we look for self-actualization [1]. We want to demonstrate how capable we are. Challenge is the core and mainspring of all human activities. As our bodies and minds are different from person to person, it brings diversification and personalization. It should be noted that diversification and personalization play important roles for evolution.

4 Babies and Grownups

Deci and Ryan proposed Self-Determination Theory [2]. They made clear that if you do the job which is internally motivated, and you make the decision by yourself, then you will get the maximum happiness and satisfaction, which cannot be provided externally. And they also emphasized the importance of our needs for growth.

Piaget proposed Cognitive Development Theory [3]. He made it clear that babies develop their cognitive capabilities up to 2 years old. Betty Edwards, American sketch artist, pointed out that children draw a sketch as they see. Their sketches show the Real World. But after seven, they draw sketches based on concepts [4]. Saint-Exupery also wrote the Little Prince [5]. In this book, when the Little Prince drew a sketch of a snake swallowing an elephant, the grownups said "It's a hat".

Babies are seeing or perceiving the Real World correctly. But grownups interpret the environments and situations based on knowledge. Knowledge is a structured collection of past experiences. But we must be aware that experience is very much personal. We often mistake knowledge is objective. It is not.

As the world is changing frequently, extensively, and what make the problem more difficult unpredictably, we need to perceive the Real World as it is, just as babies do.

5 Why Are Living Things Called "Creatures"?

Living things are called "Creatures". Why are they called that way? It is because they create "movement". Living things create movement to survive and grow. The Real World is changing every minute, so to cope with the changes, we need to create movement. Let us take swimming for example. Then, we can understand easily. As our bodies and our ways of moving our bodies are different from person to person, we have no other way than to learn to swim in our own way. We should realize babies learn to walk by themselves and we learn to swim in the same way.

6 Verbal and Nonverbal

Until recently, most objects we come across in our daily life are hard. So, they were called "hardware". But material engineering is progressing rapidly, and materials are getting softer and softer. When objects were hard, we could easily identify parameters. In addition to that, changes were smooth, so we could differentiate them and could

predict the future. Engineers could foretell the operating conditions of their machines and products. Thus, engineers come to focus their efforts on the idea of control, and they paid their efforts to realize better performing products. In short, functions of products played an important role in traditional engineering. But the Real World comes to change frequently, extensively, and unpredictably.

Human movement is divided into two: external one is called Motion, and internal one Motor. Bernstein made it clear that at the latter stage, when we get close to our target object, our muscles harden and move together with our skeleton as a musculoskeletal system. Then, we can identify parameters easily and can apply mathematical approaches. But at the early stage, our motion trajectories vary widely from time to time and from person to person, because we need to cope with the rapidly changing the Real World by Coordinating many body parts and balancing our bodies. Thus, "Coordination" becomes crucial to overcome the challenge of the frequently, extensively, and unpredictably changing Real World. Such movement cannot be verbally expressed. Control is a verbal world and data there is nothing other than numbers. But data for Coordination are information. Then, how can we represent such nonverbal information? We use images or patterns to convey such nonverbal information.

7 Digital and Analog

DX (Digital Transformation) is getting wide attention these days. But we should remember there are analog things that carry signals. Blood is one. Even when our brain stops processing digital information, blood carries signals and keep other organs working. So, within 3 h after brain death, we can transplant our organs to others.

Haptics is getting wide attention these days, too. Usually, it is discussed as a skin sensation. But if we remember the role of current and voltage in electrical engineering, we should note that haptics is also deeply associated with our deep sensation or proprioception. We "feel" the Real World with the whole body. We have been "thinking", but we forgot to "feel. Analog plays an important role for generating the "feeling".

8 Intelligence

8.1 Mind-Body-Brain

We often talk about Mind-Body-Brain. But we should remember brain is not directly interacting with the Real World. Our body does. And we "feel" or "perceive" the current environment and situation and make decisions what actions we should take to cope with the current situation. It is Mind which directly processes information about the Real World outside (Fig. 2).

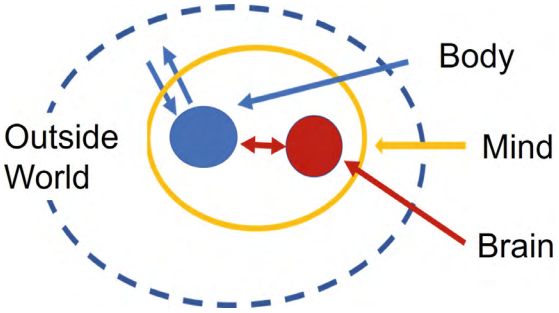


Fig. 2. Mind-Body-Brain

8.2 What the Octopus Teaches Us

Although octopuses have large heads, they do not inherit any knowledge from their previous generations. They die immediately after their babies are born. So, they live on their instinct alone. Still, they are known as experts of escape. They can escape from any environments and situations. They can even from the screwed containers. The octopus is possible because they make decisions based on wisdom. They interact with the outside world with their bodies and perceive or recognize the situation. The octopus is one of a very few invertebrates which can recognize self in a mirror. This is considered due to their excellent feeling capabilities of movement.

Even in the case of vertebrates, only humans and apes can recognize self in a mirror. Although octopus heads are big, their brain capability level is the same as dogs. Dogs cannot self-recognize in a mirror. So, this demonstrates how the "feeling of movement" plays an important role.

8.3 Static to Dynamic

To process movements, we need to move from static to dynamic. Deep-learning AI is attracting wide attention these days, but the neural network used is static. To process movement, we need a dynamic approach. It is RNN (Recurrent Neural Network). And if we introduce Reservoir Computing, we can manage output (Fig. 3), Reservoir Computing enables us to introduce micro technologies. So, we can take a big step forward toward human machine integration. Machines will be part of our bodies and our physical and mental capabilities will be enhanced significantly (Fig. 3).

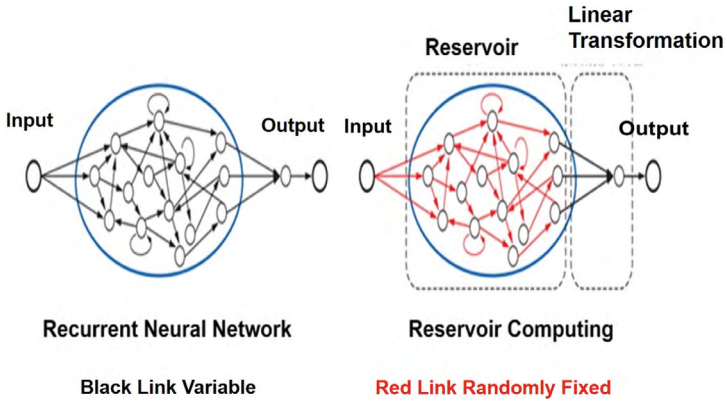


Fig. 3. Recurrent neural network and reservoir computing

8.4 Intelligence: Its Original Meaning

Intelligence originates from the Latin "intelligere". It means to "understand" or to "perceive". We perceive the current situation and understand what actions we should take. As the space is limited, the details are omitted here. Please refer to [6].

9 Society We Wish to Bring Forth

Table 1 and Table 2 show the core idea of this paper. As the current Industrial Society is getting close to its ceiling and many issues are emerging, now is the time for us to think

Table 1. Society Today and Tomorrow

	Today	Tomorrow
World	Closed with boundary	Open without boundary
Engineering Activity	Technical Problem Solving, How Control	Society Goal Finding, What, Why Coordination
Focus	Now Material Needs Reproducibility Maintenance, Robustness	Future Mental Needs Creation Growth
Perspective	Deeper and deeper Fixed. Static	Wider and wider Various, Dynamic
Dimension	Very Small	Very Large Multidimensional

about the next society. These tables point out what society can be expected and how we can get there.

Table 2. Society Today and Tomorrow

	Today	Tomorrow
Experience	Past, Use	Now, Create
Interaction with the Real World	Indirect	Direct, Real Time
Intelligence	Knowledge, Brain Understanding	Wisdom, Body Perception, Cognition
Value	Product, Material Needs Function, Single Consumer	Process, Mental Needs Service, Multi Customer
Work	For others, Passive	For yourself, Active
Data	Numerical Value Quantitative	Information Qualitative
Scale	Cardinal	Ordinal

10 Summary

This paper points out that we need to move ahead to the direction of harmonization of artificial and natural world. Since the Industrial Revolution, we have been too much devoted to artificial world only. We need to bring back natural world. Then, we can integrate humans and machines. We can work truly together on the same team. Movement plays a crucial role for their collaboration and orchestration. Then, everybody, young and old, can enjoy his or her life.

Let us take a big step forward to achieve this goal.

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Maintenance Service Management Model Based on Vehicle Routing Problem and Time Study to Reduce Lead Time in an ATM Maintenance Company

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Abstract. The maintenance service sector shows continuous growth since the incorporation of machines for the development of operations. However, in Peru, the type of service they provide does not meet certain essential aspects to satisfy the demand, due to the excess time in the attention of the services and arrival at the wrong time for the attention. That is why the main objective of the project is to reduce the lead time to comply with the annual schedule, since there is a loss of 33.44% of the billing of the maintenance service for the year 2019. For this reason, a model is designed of maintenance service management that includes the assignment of the route by the Vehicle Routing Problem through the Euclidean distance and the standardization of processes through the study of times. Finally, it has been possible to reduce lead time and comply with the maintenance schedule.

Keywords: Vehicle Routing Problem (VRP) · Time study · Process standardization · Service management · ATMs

1 Introduction

Currently, the competitiveness of an organization is directly linked to the quality and fulfillment of the service provided. Mainly, service companies should focus on this, since they measure their efficiency through service times and this is reflected in customer satisfaction [1]. Such is the case of banking organizations that have expanded their services through: internet banking, mobile banking, correspondent agents, branches and ATMs. On the other hand, the automatic teller machines allowed to increase the net profits captured by them, by which it ratifies the increase in the availability of ATMs [2]. In Peru, between 2005 and 2016 the use of these ATMs generated an increase of 302% in Metropolitan Lima and Callao [3]. In addition, in 2017 it investigated that the installed base would exceed 4 million ATMs in 2024 [4].

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 1178–1185, 2022.
https://doi.org/10.1007/978-3-030-85540-6_151

The availability of these banking machines for the user is essential, since it is directly related to the satisfaction of the service [5]. Therefore, it is important to keep ATMs operational as long as possible. Due to the inoperability caused by the presence of breakdowns and deterioration due to the constant use of the machines, the need arises to carry out preventive bank maintenance in the established time. However, the lack of planning of activities in the services to be performed, the inadequate allocation of routes, unproductive times, disorder and the lack of procedures are causing the increase in lead time [6, 7], which prevents compliance with the timeline in its entirety. For this reason, various contributions have been made to the literature related to non-compliance with services within a specified period and an increase in maintenance cycle time. On the one hand, [8] used the standardization of operations and time studies, with which they obtained a reduction in their times in 83% of their activities. On the other hand, [9, 10] developed studies on route planning and the result was compliance with the demand presented and the limitation of transit time to 30 min.

This case study is developed based on a service company that provides comprehensive maintenance to banking machines. Also, contribute with the application of Industrial Engineering tools to companies in the same field, since they tend to be more focused on the production area. In addition, it is intended to contribute with literature to the state of the art, since the research carried out did not obtain a considerable amount of studies for the ATM maintenance industry.

2 Estate of the Art

2.1 Service Management Model of a Maintenance Company

Maintenance planning and management is a crucial issue in various types of industries, such as power plants and generating unit systems, utility industries, companies that provide maintenance services, among others. Maintenance is divided into two types: corrective and preventive maintenance. The first must be applied to a machine that has failed in order for it to be operational again. The second is used to improve the state of a machine in operation, its objective is to postpone or avoid failures. Generally, it is preferred to avoid corrective maintenance, through adequate preventive maintenance. This is because corrective measures are more expensive and time consuming compared to preventives [11]. That is why various researchers define the importance of preventive maintenance service management as it is essential for machines in constant use, such as automatic teller machines (ATMs) [12, 13].

Due to the aforementioned, it seeks to deepen investigations into the preventive maintenance of ATMs to strengthen and optimize the service provided by these companies, through the improvement of times, the fulfillment of the demands requested by the client and the correct management services [14, 15].

2.2 Vehicle Routing Management in Maintenance Service Companies

Maintenance service management becomes more complex when the machines are geographically distributed, since, in addition to assigning maintenance operations to the

personnel in charge, it is necessary to assign a sequence of visits. To do this, distances, route restrictions and the travel time required to reach the service assets [12, 16] must be considered. Due to the complexity of geographically distributed services, route management tools have been used in the search for solutions to determine the ideal route. Various studies agree that the Vehicle Routing Problem (VRP) tool is the most appropriate, since it carries out the planning of the technicians' scheduling according to their abilities to prepare maintenance, route management and reduces overall costs [7, 10]. In a case study of VRP, reduced its travel time by 45.5% and another favorable case was to maximize the number of clients to serve in the different places, which achieved an increase from 55% to 85% [17, 18]. In turn, VRP makes it possible to implement a logistics network, where the nodes correspond to the customers and each technician will be available to carry out such operations quickly and efficiently [18, 19].

The contribution of the aforementioned authors shows that the efficiency of route planning and management is supported by the Vehicle Routing Problem (VRP) tool and provides the solution to the problem of covering services that are geographically distributed in various points [20, 21].

2.3 Standardization of Processes Through Time Study

To guarantee the efficiency of the quality of the service, the sequence of activities for the development of the service must be considered. However, many companies within the maintenance services sector do not standardize their operations, as a result of this an increase in inefficiency in services is generated. Non-standardized work increases processing time, process waste, downtime, and unnecessary activities. As a result, all these problems cause non-fulfillment of the demand in the services. That is why standardized work is a vital tool to solve process problems and generate results in organizational performance by reducing cycle times, which allows increasing efficiency and productivity [6, 22, 23].

Some studies report applications of process standardization, through the study of time in service companies to solve problems, where non-value-added activities (NPV) were reduced by 17% and the standard time was significantly reduced. From a similar perspective, the time study was applied to a service maintenance line in a process stage, which decreased the standard time from 244 to 199 s, that is, by 18.44%. Likewise, with the standardization of the service process, the service capacity of an automotive maintenance workshop was increased by optimizing its service time from 90 to 70 min. Similarly, an investigation on the standardization of operations managed to reduce the times of its activities by 83%. In addition, of the 149 initial operations, 29 were eliminated, which achieved a decrease of 30% in the times [6, 8, 24].

3 Input

3.1 Proposed Model

In the present proposed model, which is integrated by the VRP tools with Euclidean distance, which allows route management. Then, standardization is carried out through the study of times. Finally, the proposed flow is obtained that allows a maintenance service management model for the case study (Fig. 1).

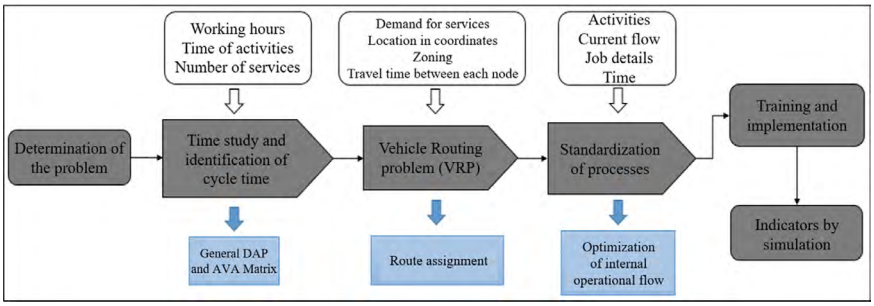


Fig. 1. Proposed model

3.2 Model Detail

Component 1 - Time Study. In the development of this component, there is the preliminary phase in which the problem is determined and the necessary information is entered for the analysis and previous study of the activities involved in the development of maintenance services. Simultaneously, an activities and processes diagram is made. Then, the sample size necessary for the study of times was determined, obtaining the standard time of each activity, the cycle time of the system and identifying the activities that generated the lead time increase. Finally, an AVA matrix is made to analyze the activities and the contribution value of each one to propose improvements in each of them and increase the efficiency of the processes.

Component 2 - VRP Route Assignment. The objective of this tool is to optimize the travel distance between each point in the shortest possible time by selecting the optimal route. This consists of two stages consisting of activities for its execution of the VRP using the Euclidean distance formula.

Stage 1. In the first stage, the alternatives present in the annual preventive maintenance schedule are determined.

- The first step, zoning services in districts according to the amount of services.
- The second step will prioritize the district with the most maintenance.
- The third step, determine the points in Longitude (X) and Latitude (Y) coordinates, to be able to identify the exact location of the service point using the Google Earth Pro program.

Stage 2

- Fourth step, the VRP formula with Euclidean distance is executed to obtain the distance of the optimal route to be made.

$$d = \sqrt{(X_2 - X_1)^2 + (Y_2 - Y_1)^2} \tag{1}$$

- Fifth step, the route matrix is made and the alternative with the shortest distance is selected.
- Sixth step, the waypoints are assigned.

Component 3 - Process Standardization. This tool seeks to analyze current processes in order to propose or determine the work flow, control and integration with other processes to guarantee the efficiency of the maintenance service.

Stage *1.* An analysis of current activity and a time study are carried out.
Stage 2. An AVA matrix is made to analyze the activities and the contribution value of each one within the services. For them, improvements are proposed in each of them to increase efficiency in the processes.
Stage 3. The maintenance execution is standardized through a check list with the list of activities and their respective times, taking an average time of 145 min to execute the maintenance.
Stage 4. Job profiles are established to be fulfilled by the collaborators involved in the service, in this way the collaborators will be better trained to carry out the activity, thereby reducing the service time.
Stage 5. The proposed flow is elaborated, we use the activity disaggregation diagram from the previous stage.
Stage 6. To achieve a correct implementation of the standardization of processes, it is necessary to develop a culture of improvement in the collaborators, since in manual processes such as those developed within the services, labor is a fundamental piece to increase efficiency.

That is why, during the implementation, follow-up formats are proposed to the technician and service operators, which will then be analyzed to develop continuous improvements.

3.3 Model Indicators

Table 1 shows the list of indicators that were used for the validation of the developed model.

Table 1. Model indicators

Indicator	Formula	Expected Value
Compliance with the schedule	$CC = \frac{Maintenance\ services\ performed}{Total\ demand\ for\ services} \times 100$	90% 70% 40%
Efficiency of service attention	$EAS = \frac{Individual\ actual\ service\ time}{Individual\ theoretical\ service\ time} \times 100$	85.5% 70% 55%
Maintenance management efficiency	$EGM = \frac{Total\ run\ time}{Total\ schedule\ time} \times 100$	87 % 70% 50 %

4 Validation

4.1 Initial Diagnosis or Previous Study

The company presents a significant loss of opportunity in its main operation which is, preventive maintenance, this service is executed based on an annual schedule which is only being executed by 54.40% of the total; services not executed (45.60%), generate a significant monetary impact of S/. 34,746.13. The main causes of this problem are the excessive time in the attention of the services and arrival at the wrong time for the attention that represent 56% and 44% respectively. Likewise, it was identified that a service is performed in 252 min, but based on the times of technical reports this increases to 399 min due to inadequate management and development of the service, generating an inefficiency of 58.33%, a percentage that is found by above the sector.

4.2 Validation Design and Comparison with the Initial Diagnosis

For the validation of the expected results of the proposed improvement model, the current design of the ATM preventive maintenance services system was carried out in the Arena software. Through the system it was identified that the 47% of non-compliance with services is due to high travel time and the delay in checking the ATM.

The service process begins when the request for the execution of preventive maintenance services from the schedule sent by the client arrives. That is why the verification of the availability of the care is carried out, which is made the verification of the availability of the ATMs and office to be able to be executed and provide the service.

Then, the reception is carried out, which is the time it takes for the supervisor to receive and corroborate the information with the detailed schedule. To proceed to carry out the route management, which is assigned the route to carry out the route to the point. Then, we proceed to develop the assignment of the personnel in charge of the service. Those in charge go to the point made with the value carrier to proceed with the preventive maintenance service. Finally, the service ends when the technician in charge communicates with the detailed supervisor the completion of the service and the subsequent completion of the technical report developed.

For the improved simulator, the integrated VRP tool managed to reduce travel time by 54.54%. The standardization of processes that was executed in all the service activities had an impact on the cycle time, the maintenance service time was reduced by 71 min. Which means a 30% reduction in the delay time. After applying these improvements, the efficiency of the maintenance management is evaluated in percentage, the efficiency of the service in percentage, the utilization of the operator in percentage and the fulfillment of the preventive maintenance schedule in units.

The results show (see Table 2) that the proposal developed allowed to meet the objective of the research project, achieving an increase from 729 to 1518 preventive maintenance, generating an increase of 108.23%. In addition, in the output of the Arena report, in the current situation a 55.11% utilization of the technician is generated in the current process and in the improvement process 99.98% generating an increase of 81.42%.

Table 2. Simulation result

	Current situation	Improvement situation	% Increment
Maintenance executed	729	1,518	108.23%
Maintenance not executed	613.00	–	–
Cost	S/. 56,700.00	S/. 56,700.00	–
Gross profit	S/. 1,824.12	S/. 65,165.04	3472.41%

5 Conclusions

Through the results presented, the positive impact generated by the effectiveness of the model is evidenced. An increase in the efficiency of the maintenance service was obtained from 41.70% to 99.98% by jointly applying the VRP tools and process standardization, through the study of times in an environment with particular characteristics.

Based on the simulation carried out by the Arena software, it is observed that in the base or current situation only 730 maintenance services can be performed, in addition, that the percentage of use of the technician is 55.11%. The implementation of the improvement proposal considered as scenario 2 has a greater scope and improves the efficiency of services, which allows an increase in bank preventive maintenance executions to 1518, this being an increase of 108.23%. In turn, it is evident that the percentage of use of the technician increased to 99.98%.

The investigation of the reviewed literature, validates the application of the techniques developed for the scenarios. In the same way, the results achieved as — % efficiency is evidenced within the results of the investigated case studies.

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Admission Points Score to Predict Undergraduate Performance - Comparing Quantity Surveying vs. Real Estate

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Abstract. The Department of Construction Economics, University of Pretoria, offers three-year BSc programmes in Quantity Surveying (QS) and Real Estate (RE) and use an Admission Points Score (APS) of 30, based on school performance as the main entry threshold. The validity of the current threshold requirements is being reconsidered to improve first-year students' marks and the throughput rate of enrolled students. A 2020 study found that undergraduate performance (average first-year marks, likelihood to qualify in three years and to qualify with distinction) amongst QS students from 2010 to 2015 strongly correlated with higher APS and better school marks in Mathematics and Natural Science. This new study considered the performance of RE students against their APS as the independent variable. For both RE and QS students a higher APS correlated with better first-year performance, but for average first-year marks and for students who managed to graduate, the gradients of the regression lines were steeper for RE students than for QS students. The findings will assist informed decisions about amending future entry threshold levels and add to our understanding of the relationships between school-level performance and undergraduate performance.

Keywords: APS · Real Estate · School performance · South Africa · Undergraduate performance

1 Introduction

The demands of tertiary studies often present significant challenges for students starting their undergraduate studies. The skills and ability of students often fail to cope with studying independently, the rapid pace of work and the quantum and complexity of academic curriculum. Tertiary institutions will typically address the problem by careful attention to selection criteria, bridging courses, and support for students in challenging modules [1]. An improving South African matric pass rate is not aiding first-year university throughput rates. Of particular concern is the persistent poor student performance in mathematics, physics and languages [2].

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 1186–1192, 2022.
https://doi.org/10.1007/978-3-030-85540-6_152

2 Literature

Academic programmes for Real Estate (RE) are often located or offered within colleges or faculties of business and management sciences. Smith and Schumacher [3] as well as Brookshire and Palocsay [4] found that grades in the final year of high school and performance in college mathematics placement screening were significantly linked to success in undergraduate studies in business management. A study by Allen and Carter [5] conceded that predicting the academic success of real estate undergraduate students are complicated by various intellectual and non-intellectual variables such as intelligence, study habits and demographics. However, success in undergraduate real estate studies was significantly linked to core knowledge courses taken early in their study plans.

Numerous studies in South Africa and abroad have confirmed a positive correlation between school marks in Mathematics and undergraduate performance in quantitative modules. Higher education institutions therefore often include entry thresholds to undergraduate admission on these [6–10].

A 2007 study by Scott, Yeld and Hendry [11] found the South African school curriculum not to be an adequate base for higher education studies. In 2020 Prince and Frith [12] argued that the academic numeracy and mathematical competence of only 13% of South African university students can be classified as proficient for higher education expectations. School mathematics that often focuses on algorithms and procedural knowledge rather than insight is a major contributor to this problem [13].

Schöer *et al.* [14] found that the NSC Mathematics results are 12–13% higher than the higher-grade Mathematics marks of the previous Senior Certificate system for students with similar undergraduate performance.

Similar studies to this research were done in the department on BScQS entrants from 2010 to 2015. Students with an APS of 32 and higher consistently outperformed students with lower marks in aspects such as average first-year marks, likelihood to qualify in three years and to qualify with distinction [15]. Students with better NSC marks in Mathematics and Natural Science also achieved higher marks and better first-time pass rates in challenging quantitative undergraduate modules [16].

RE students not equipped with the underlying foundation of academic numeracy will often fail in tertiary programmes that teach advanced mathematical principles and apply them to aspects such as time value for money, property valuation and investment calculations. Therefore, an argument is proposed for a higher APS score, especially in mathematical subjects of RE students being admitted to the programme, to ensure a higher probability that students will interpret these numeric concepts on the levels required.

3 The Methodology

The study followed a similar methodology as the study focused on BScQS students by considering the weighted average undergraduate performance of BScRE students registered from 2010 to 2015 as dependent variables against their APS as the independent variable. Aspects of undergraduate performance such as the weighted first-year marks,

the throughput rate of enrolled students, and the percentage of enrolled students who qualified were considered. The data were treated and described using the following structured approach:

- Group 1 (students with an APS of <30);
- Group 2 (students with an APS of 30 or 31);
- Group 3 (students with an APS of 32 or 33);
- Group 4 (students with an APS of 34 or 35);
- Group 5 (students with an APS of 36 or 37);
- Group 6 (students with an APS of 38 or 39); and
- Group 7 (students with an APS of ≥40).

4 The Data and Findings

The cohort size of the 86 students first time entering BScRE students in the study varied between a minimum cohort of 6 in 2011 and a maximum of 21 students in 2013.

4.1 Overall Relationships Between APS and Average First-Year Marks

The combined data set revealed a relatively weak correlation between the APS as the independent variable and the weighted average first-year marks as the dependent variable. The Pearson's correlation of 0,465 and the resulting coefficients of determination of 0,216225 mean that only 21,62% of the dependent variables' variability can be ascribed to the variability in the independent variables. The size of the stratified groups and the average APS per group are detailed in Table 1.

Table 1. The number of first-time entering students per APS stratified grouping.

Stratified APS Groups	<30	30 & 31	32 & 33	34 & 35	36 & 37	38 & 39	≥40
Number of students enrolled	30	21	14	8	4	6	3
Average APS	27.8	30.6	32.3	34.4	36.5	38.3	40.7

4.2 Weighted Average Marks in First-Year

The study considered the weighted average first-year mark of students as the dependent variable. The average APS data is used as the independent variable within the different stratified groups. Table 2A details a simple linear regression line of the findings. Figure 1 confirms a strong positive relationship exists between the independent and dependent variables. The simple linear regression line slope of 2,63 indicates a very significant increase in average first-year marks for a corresponding rise in APS.

Table 2. Weighted average marks in first-year of study

Stratified APS Groups	<30	30 & 31	32 & 33	34 & 35	36 & 37	38 & 39	≥40	Slope	Y-intercept	Error ϵ
Average APS	27.8	30.6	32.3	34.4	36.5	38.3	40.7			
Weighted average marks (%)	35.27	44.05	40.67	44.40	56.02	59.72	70.84	2.63	−40.39	4.207

The high Pearson's correlation coefficient of 0,9515 and the coefficient of determination of 0,9054 confirm the strong correlation. However, using stratified averaged data as an independent variable must also be considered.

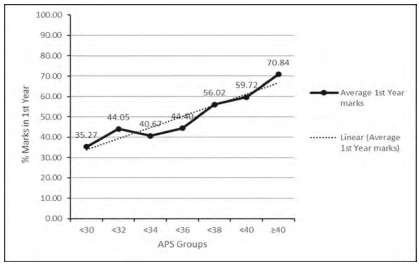


Fig. 1. Weighted average marks in the first year of study

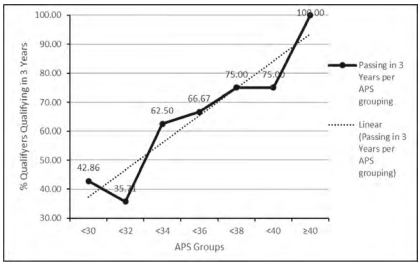


Fig. 2. % of Students qualifying in 3 years

4.3 Through-Put of Students

The study then perused the % of students qualifying in the minimum period of three years as the Department requires a better throughput rate of students. This evaluation took the average APS per group as the independent variable, and the dependent variable was the % of students qualifying in three years (see Table 3). A strong positive relationship exists between the independent and dependent variables. The slope of the simple linear regression line of 4,45 indicated a very significant increase in % of students qualifying in 3 years for a corresponding rise in APS (see Fig. 2). The high Pearson's correlation coefficient of 0,9328 and the coefficient of determination of 0,8701 confirm the strong correlation. However, using stratified averaged data as an independent variable must also be considered.

Table 3. % of Students qualifying in three years

Stratified APS Groups	<30	30 & 31	32 & 33	34 & 35	36 & 37	38 & 39	≥40	Slope	Y intercept	Error ϵ
Average APS	27.8	30.6	32.3	34.4	36.5	38.3	40.7			
Students qualifying	7	14	8	3	4	4	3			
Students qualifying in 3 years	3	5	5	2	3	3	3			
% Qualifying in 3 years	42.86	35.71	62.50	66.67	75.00	75.00	100.0	4.45	−87.62	1.781

4.4 Number of Students Who Manage to Qualify

Another measure of success is the number of students that eventually qualified. The study also considered the % of students eventually qualifying per stratified group. The average APS per group was the independent variable, and the % of students qualifying the dependent variable (see Table 4).

Table 4. % of Students that qualified

Stratified APS Groups	<30	30 & 31	32 & 33	34 & 35	36 & 37	38 & 39	≥40	Slope	Y-intercept	Error ϵ
Average APS	27.8	30.6	32.3	34.4	36.5	38.3	40.7			
Registered students	30	21	14	8	4	6	3			
Students qualifying	7	14	8	3	4	4	3			
% Qualifying	23.33	66.67	57.14	37.50	100.00	66.67	100.0	4.81	−100.7	3.267

The data revealed significant variability per stratified group in the percentage of students that managed to complete their academic programme. However, a positive relationship did exist between the independent and dependent variables. The Pearson's correlation coefficients of 0,7502 and the coefficient of determination of 0,5627 meant that 56,27% of the variability in the students who qualified can be ascribed to their APS score. The slope of the simple linear regression line of 4,81 indicated a very strong increase in % of students eventually qualifying for a corresponding rise in APS (see Fig. 3).

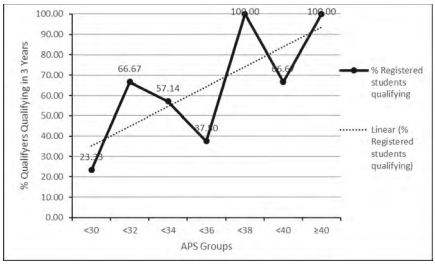


Fig. 3. % of Students that qualified

5 Conclusions

A positive and significant correlation existed between the APS of RE students and their undergraduate performance. The ability of students in the various groups to complete their programmes successfully did, however, vary considerably. The inconsistent performance of these students indicates that even though the APS may be a prominent indicator of undergraduate performance, other factors also need to be considered.

The Pearson's correlation between APS and first-year marks was high at 0,9515. Compared to their QS counterparts, the RE students displayed more pronounced positive relationships between APS and undergraduate performance. When comparing the results of QS and RE students, the slope of the simple regression lines for weighted first year marks was 26,2% steeper for RE students than for QS students {[(2,63–1,94)/2,63] × 100/1%}; 33,3% steeper for qualifying eventually {[(4,81–3,21)/4,81] × 100/1%}; but for qualifying in three years; QS students had a 33,7% steeper slope {[(5,95–4,45)/4,45] × 100/1%}.

The first-year marks of RE students supported the findings of Schöer *et al.* [8] that NSC marks may be too lenient. The average school marks of the group 7 RE students (APS $\leq$ 40) typically were >80%, compared to their average first-year mark of 70,8%.

6 Recommendations

Based on these findings the Department of Construction Economics is recommended to seriously consider increasing the admission requirements for the APS. It is recommended that the study be continued for student cohorts from 2016 onwards to inform the Department of students' relative performance in the rapidly changing demography of the South African tertiary environment. The study may also be extended to include other institutions nationally that offer a similar qualification. The variability in student performance that may be due to other variables should also be investigated.

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Integrated Lean Model Under the Theory of Constraints Approach that Allows Increased Production in Cement Companies in Lima, Peru

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Abstract. Lean manufacturing and Constraint Theory (TOC) are tools that specialize in continuous improvement. The proposal focuses on obtaining the best result by executing the 5 phases of the Thinking process, an introductory tool to TOC, which, hand in hand with Lean Manufacturing tools, will be responsible for eliminating activities that do not add value to the process and optimize the process. In this way, the improvement proposal is applied to the cement industry in Pisco, Ica. This industry poses a growing demand, being directly affected by low productivity compared to other cement companies. The following research develops from the need to improve productivity, as well as to increase the production capacity and competitiveness of companies in the construction segment. In such matter, these methods will reduce high inventory costs, unmet demand costs, low level of service and logistical cost overruns, among other problems that the company is dealing.

Keywords: TOC · Process improvement · Lean manufacturing · Productivity · Bottleneck

1 Introduction

Through time the cement industry has been one of the fundamental pieces in the construction process worldwide. At the beginning of the 20th century, Portland cement exports to Latin America grew notably, but it was not until 1900 that cement production soared in a remarkable way, doubling the records of five years ago, which caused that natural cement be replaced by Portland cement [1]. Additionally, the cement industry and other types of concretes made from cement have been, over time, one of the main most profitable and remunerative businesses around the world, mainly in Latin America, where sales of this product have been doubling every year. 10 years as a consequence of high population growth rates [2].

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 1193–1200, 2022.
https://doi.org/10.1007/978-3-030-85540-6_153

Among the prominent list of cement producers in Latin America we have countries such as Cuba (1918), Argentina (1919), Peru (1922), Ecuador (1923), Mexico (1923), Brazil (1926) and Bolivia (1928) [3]. Likewise, Latin America over time has become one of the regions with the greatest investment potential in the construction sector. On the other hand, one of the main cement suppliers in Peru is the country of Vietnam, which has the largest share of the national cement market with 85%, followed well below China with 9% and Mexico with 3% [4].

At present, "the fifth sector that contributes the most to the Peruvian economy is the construction sector, since it represents a total of 5.1% of GDP [5]". Consequently, we can currently see that the share of the cement market in Peru, according to the National Institute of Statistics and Information, has increased by 3.99% in February 2020 [6], compared to the same month of last year; according to the technical report on Economic Activity Advancement. This change is due to the growth of construction works in both the private and public sectors. Likewise, this recovery will drive the construction sector to increase by 6.7% at the beginning of March of this year, according to the Institute of Economics and Business Development (IEDEP) of the Lima Chamber of Commerce [7, 8]. "However, the current health crisis has caused cement imports to be reduced by 13.2%, as a result of the arrival of COVID-19, the local and global economic outlook has been drastically affected, causing thousands of works to be paralyzed. With this case, we can exemplify that over time and currently one of the main problems of the cement industry has been the variance of its demand, which is linked to excess inventory and low production capacity. For this reason, it is necessary to previously carry out a demand forecast which will help us to estimate the exact amount that is required [9]. In this way, a continuous improvement model can be proposed which will be based on increasing production capacity.

The approach of the proposal is based on the TOC and Lean Manufacturing method, which focus on the optimization of production processes, which generate an increase in productivity as well as the competitiveness of production systems [10].

2 State of the Art

Lean Manufacturing. It is a methodology, which is based on continuous improvement and mainly on the efficiency of operations; that is, one of its main objectives is to be able to generate higher production with the least amount of resources possible [11]. Therefore, this model focuses on reducing operation costs, production cycle time, waiting times and being able to eliminate sources of waste in the production flow, which do not generate added value to the product [12]. Likewise, there are several Lean tools, which are identified as the most applied in industrial processes and among them we have SMED, Value Stream Mapping (VSM), 5S, among others.

Total Productive Maintenance (TPM). This tool is used with the aim of reducing or eliminating the losses generated by unscheduled machine shutdowns, as well as equipment and process failures, among others. This methodology consists of six pillars which are the following: Focused improvements, maintenance autonomous, planned, quality, education and training, and last but not least safety and the environment [13].

Autonomous Maintenance (Jishu Hozen). In this second pillar, which is autonomous maintenance, it focuses on inspections whether they are cleaning, lubrication, failures, among others, also this type of maintenance is carried out hand in hand with the help of the workers of the operation of each process. The objective of performing autonomous maintenance is to be able to contribute to the preservation of the useful life of the equipment, through prevention [14].

Value Stream Mapping (VSM). It is a tool that allows us to have a broader panorama of all processes, because it helps us to visualize which activities do not add value to the process flow, in this way an improvement plan is established which allows eliminating all waste within the production process. Likewise, Value Stream Mapping is an input tool which analyzes the current situation and calculates downtime, as well as helping to identify the bottleneck in order to reduce or eliminate it.

Theory of Constraints (TOC). It is a methodology, which focuses on exploiting the bottleneck in the manufacturing process, that is, it is responsible for reducing the restriction presented by the system, which causes the production flow to become slower and slower, inefficient, which results in low productivity. This event usually occurs very often in manufacturing companies which present a very irregular demand, since they do not have a correct standardization of processes and products [15].

Additionally, it should be mentioned that the tool has 5 steps which are the following:

1. Identify - Identify the constraint
2. Exploit - Decide how the restriction presented by the system will be addressed and solved
3. Subordinate - The activities that are part of the process must comply with and support the defined actions.
4. Raise - If the restriction persists, it is necessary to evaluate other alternatives
5. Repeat - The restriction was resolved, you must go back to the first step to address the next limitation that the system has and in this way, to be able to optimize the process [15]

Thinking Process (TP). This tool is part of the theory of restrictions, which was divided into 5 phases:

1. Current reality tree (CRT) - Shows the initial condition or reality of the problem. It is a chain of cause and effect for specific situations.
2. ECs - Search for a possible solution for the conditions initially encountered.
3. Future Reality Tree (FRT) - Presents the optimistic option of the system.
4. Prerequisite Trees (PRT) - Identify possible obstacles when implementing the solution.
5. Transition Trees (TRT) - Determine the action required to implement the solution [16].

DBR (Drum - Buffer - Rope). This tool is part of the Theory of Constraints technique which adopts linear programming in order to optimize the production planning procedure. In order to reduce the time of operations and in this way, it is possible to avoid fluctuations in the process [17].

The Drum symbolizes all the production time granted by the previously visualized and employed restriction. The Buffer is a small amount of raw material which is placed to prevent it from stopping and the productive flow is not impaired, in this way the daily production will not be affected. Finally, the Rope (Rope) represents the speed with which all the raw material is released at the beginning of operations [18].

3 Case Study

3.1 A. Background

The company XYZ belongs to the construction industry is a company which is dedicated to the distribution of cement. The company's standard product is the production of Portland Cement and Premium MS Cement. The XYZ company, despite having started operations in August 2019, is presenting a sustainable growth that allows it to position itself strongly in the southern area of Lima, being the districts of: Villa el Salvador, Villa María del Triunfo, Lurín and Sur Chico to Pucusana. However, it is currently being hit by the current COVID-19 pandemic, which has caused the country to be in a state of emergency and with this restricts its operations and can only serve the following areas: Agriculture, Agroindustry, Oil, Food and Mining. Although it has an average sales of S/. 86,979.71. Currently it has problems with accounts receivable, which have a significant percentage since they have a maturity greater than 60 days and generate cost overruns and interest on bank loans. The main cause of these accounts receivable is the number of days it takes to rotate the inventory at the points of sale, generally customers pay once they finish selling all the cement or when they require more. By comparison, in the previous year, cement sales have reduced by 65%, which generates a great loss for the company.

3.2 Design of the Integrated Model

The proposed model is based on two methodologies that converge and seek the continuous improvement of the optimization processes, improving the productivity of the processes. Where the Lean Manufacturing and Six Sigma philosophy will focus on identifying and reducing the waste that can present the manufacturing, as well as avoid generating a variability of the processes. On the other hand, the Theory of Constraints philosophy will be based on identifying the bottleneck and will use the DBR method so that this bottleneck or restriction can be exploited.

3.3 Implementation of the Model

The model consists of 4 simple steps which focus on the previously investigated tools, which seek to increase the productivity of the company in this case study, according to Fig. 1.

The TOC tool is broken down into the following steps:

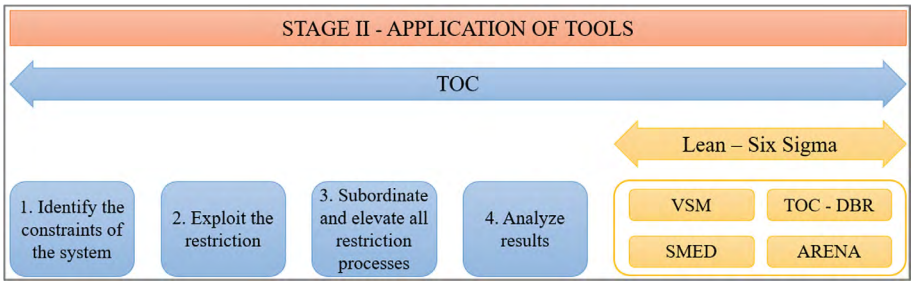


Fig. 1. Application of the tools

Step 1. The identification of the restrictions, which is based on recognizing the bottleneck in the production process which can be evidenced with the previous analysis, mainly with the elaboration of the Value Stream Mapping, since it is a tool of income (Fig. 2).

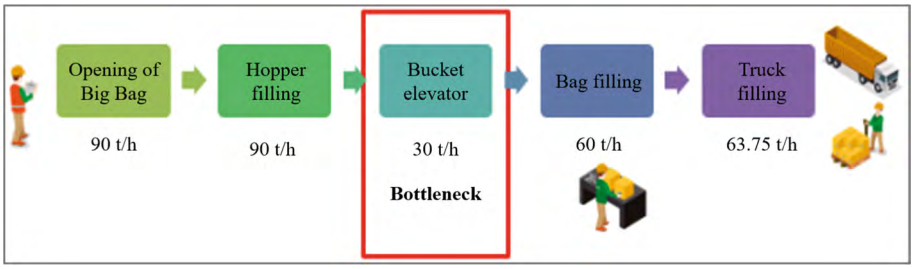


Fig. 2. Productive process

It was necessary to know the current situation of the company, so a Value Stream Mapping was carried out to identify the lead times. It began by preparing a Value Stream Mapping of the system's processes in order to determine the total time of the current production, as well as the time that the bottleneck produces in the operation was identified, this must be managed to be able to raise its restrictions. On the other hand, it was found with the help of Value Stream Mapping the optimal cycle time that should be generate in order to meet the demand which is known as Takt Time where a result of 3.2 s/unit was obtained. This time found indicates that this is the optimal time that the company should have to be able to meet the demand 100% on the days with the highest demand. On the other hand, at this stage we also find the dead times and the delay that the bottleneck generates since it only works with 50% effectiveness.

Step 2. Exploit or Reduce the bottleneck, where the SMED tool was used, which will help us eliminate any type of waste and the processes that do not generate any value to the operation, these delays have a time of 2 h.

Step 3. It is going to subordinate and elevate all the processes that revolve around the bottleneck, that is, the implementation of the improvement covers all the processes so

that in this way they can work in a joint way and in line with the restrictions. Likewise, the DBR (Drum-Buffer-Rope) tool is used, which will be in charge of reassigning the operators in the Bucket Elevator (bottleneck) processes and will check if it is possible to increase the rotation rate of the helical screws to increase productivity.

- Drum: Bucket Elevator (Helical Screw) Capacity: 30 tons/h
- Buffer: Hopper - This process must have at least 2 h of production, this is because minor failures that may occur in the plant can be solved in 2 h. Also, the (Change of belts, change of duck rim, change of blades) - Capacity: 60 tons/h
- Rope: The rope must indicate to the operators of the processes prior to the buffer that it is below the suggested level, in this case the hopper has a digital scale. If this is below the established level, the Big Bags opening process should be speeded up. The person responsible for the execution of this security measure is the storekeeper.

Step 4. The results must be analyzed and compared, in order to validate the simulation in the ARENA software, that is, the current situation must be compared to the new proposal.

4 Results

With the results obtained we can compare the current situation vs the future situation of the case study, in this way we can show the percentage of improvement, see in Table 1. A comparative analysis was carried out, in this it can be seen that the percentage of use of the bucket elevator process goes from 94% to 56%.

Table 1. Results

Outputs	Current situation	Improvement Situation 1
QueSizTraslateEC	40.9	23.09
QSysCement	47.08	33.89
QueSizBagging	22. 3	25.43
QueSizZaranda	43.02	58.04
QueSizArmedP	0.00118	0.00271
QueSizArmedN	0.22769	0.00271
QueSizPickUpMP	13.44	13.44
QueSizHopperFilling	15.22	15.62
CementNumberIn	803	1160
CementNumberOut	738	1050

(*continued*)

Table 1. (*continued*)

Outputs	Current situation	Improvement Situation 1
CementWIP	65	110
Employee1	69%	75%
Employee2	94%	56%
Employee3	82%	94%
Employee4	18%	21%
Cost	S/. 149.50	S/. 253.00
Benefit	S/. 22,140.00	S/. 31,500
Cost-Benefit	S/. 21,990.50	S/. 31,247.00

Although this increases the percentage of use of the Screen, this does not influence a major problem since being a machine it can be used 100%. Likewise, we can note that the production time was reduced by 27% and Demand failure by 19%.

5 Conclusions

We can conclude that the increase in productivity and capacity of the plant allows closing the demand gap that was had in the peak days, 300 tons/day, and the previous supply of 240 tons/day. Likewise, the application of Value Stream Mapping helped us to obtain the process that generates the bottleneck and delays production, which is the Bucket Elevator, since it takes approximately 40 min/ton. On the other hand, the Lean - Six Sigma methodology helped reduce backorders by 2% and the Arena model shows us that the time in the cement system was reduced by 29.79%, from 47 min to 33 min per truck, equivalent to 30 tons. Finally, the company presents a current production situation, an approximate of 738 bags per day and for the future situation, 1058 bags are generated per day, obtaining an increase of 48% in production, fulfilling one of the main objectives.

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Cost of Sale Reduction in a Company Within the Restaurant Industry Using a Procurement Model Based on Supply Chain Management and Lean Philosophy

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Abstract. This study mainly analyzes the increase in food and beverage (F&B) costs and its economic impact on business. Likewise, the related indicators that would cause this main indicator to increase were studied. The study was conducted and validated using a procurement simulation process of a specialized restaurant company belonging to a restaurant group. The results showed that the model proposed in the study reduces by 1.73% the main indicator of F&B cost; in addition, the related indicators are presented. Therefore, it can be confirmed that poor management, poor control of resources, such as supplies, and the absence of procurement strategies generate an excessive supply of resources to the restaurant or cause the loss of some supplies.

Keywords: Cost reduction · Food and beverage costs · Restaurant management · Supply chain

1 Introduction

The cost of food and beverages (F&B) and payroll together represent over 70% of operating costs in the restaurant sector in our country, the first being the most relevant and sensitive. In turn, the method to calculate this indicator is Cost of F&B/Net Sales [1, 2]. The problem arises when the F&B cost is not monitored on a regular basis; this can stealthily compromise profit, i.e., without the manager noticing. This research focuses, first, on quantitatively analyzing the internal operations of a restaurant and then identifying improvement opportunities within its processes. It was observed that the F&B cost indicator presented shortcomings and variability throughout 2019.

The F&B indicator is strongly related to the procurement and management of F&B throughout the year. Therefore, the goal is to propose a model for the improvement of the procurement process that will promote and ensure operational efficiency. Regarding the procurement process, there is a direct relationship between its operational efficiency and business profitability, that is, if efficiency increases, the business profitability increases.

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 1201–1208, 2022.
https://doi.org/10.1007/978-3-030-85540-6_154

2 State of the Art

2.1 Operational Efficiency in the Restaurant Sector

Companies in the restaurant sector often have a weak financial structure and are a part of a highly competitive market. This sector comprises a wide variety of segments and sizes that vary according to the service they offer: whether they are fast-food restaurants, franchises, haute cuisine restaurants, or full service or self-service restaurants. Operational efficiency is an aspect that has generated great interest among researchers because of the great variety of restaurant segments and the different factors that have to be controlled in their operations [3].

2.2 Procurement in the Restaurant Sector

Because of the strong competition in the restaurant industry, it is necessary to conduct a thorough analysis of potential procurement efforts. It is important to study the success factors in the purchase process and make a comparison of the company's purchasing patterns with those of competitors. This could help optimize purchasing patterns by introducing the appropriate actions [4]. Suppliers must be taken into consideration within this process. Trust between supply chain stakeholders has a positive impact on teamwork [5]. Holding regular meetings with suppliers and analyzing statistics are some of the actions that can optimize purchases [4]. Likewise, procurement strategies should be proposed. Strategic purchases have an important and positive impact on restaurant performance [6].

2.3 Supply Chain Management Focused on the Restaurant Sector

Intra-organizational supply chain management (SCM) has an important impact on companies' potential internal sales. This could be due to the fact that internal sales involve fewer and relatively less complicated supplier channels. Intra-organizational SCM helps achieve those channels through different functions. Thus, managers can effectively leverage the multi-functional management of supply chain organization in companies' performance teams. By doing so, they are able to achieve the desired goal rather than implementing other more complicated techniques into the inter-organizational channels of suppliers and distributors [7].

2.4 Lean Philosophy Focused on Management

Moreover, to identify how moving toward a digital supply chain improves business operational processes, lean tools such as Poka Yoke can be used [8]. Therefore, as the variety of products is rapidly increasing across companies, the "reconfiguration" concept gains importance. The reconfiguration concept becomes more useful when it is applied in conjunction with the "lean" concept. The Poka Yoke lean manufacturing technique is used to increase the capacity to diagnose the production or service system in a company [9].

2.5 Lean Supply Chain Management

The lean supply chain management (LSCM) strategy has increasingly been used to improve efficiency and reduce waste in service and production companies [10]. Effective implementation of lean within the context of a company supply chain requires proper prioritizations of lean-specific techniques within all sub-criteria to be assessed (i.e., developing an overall relative priority for lean techniques to be implemented) [11]. Very few studies, mainly in manufacturing, have integrated both the initiatives, with a shortage of studies within the context of services, particularly in hotel supply chains.

3 Contribution

The proposed model has been developed based on the integration of the lean philosophy with some SCM tools. If the model is correctly managed using the necessary resources, it produces a significant increase in sales and reduces sales costs [12]. The synergy between them identifies and reduces process errors and improves efficiency and productivity [10]. In addition, it is possible to propose purchasing strategies [7] and improve inventories management within the supplies warehouse. All this aimed at reducing costs and, consequently, making the supply chain more efficient [11, 12].

The main advantage of the model is the effectiveness of mitigating errors along the procurement process. Besides, the proposed strategies help achieve a more efficient purchase of supplies. This is a cyclic and repetitive model, i.e., procurement will always occur. Continuous supply, storage, and control of consumables must be ensured so that they are used without generating waste. It is important to mention that when repetitive tasks are involved, improvements can be made after each iteration. In addition, this model supports restaurant managers and companies in the sector, as it allows better management and mitigation of errors (Fig. 1).

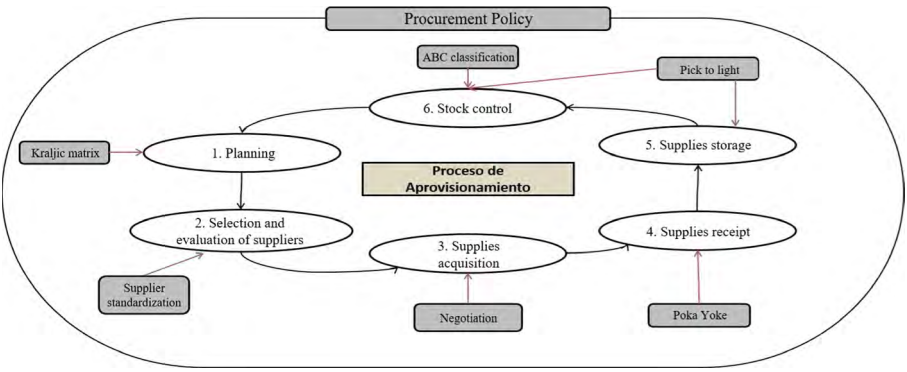


Fig. 1. Efficient procurement model

3.1 Kraljic Matrix

The proposal focuses on sorting the supplies that are required and purchased by the restaurant into the four quadrants of the Kraljic matrix. In this way, purchasing strategies can be defined for each of the supplies according to their economic impact on the business and its market complexity.

3.2 Supplier Standardization

The proposal focuses on using the supplier standardization tool in the restaurant, i.e., establishing criteria, and a weighting method to evaluate and select product suppliers.

3.3 Poka Yoke

The implementation of the tool aims at establishing a control on the process of receiving supplies, which in turn enables requesting certain standards for receiving and accepting goods from the suppliers. The proposal entails keeping track of the goods to be stored in the warehouse and conducting a previous control and evaluation of said goods.

3.4 Pick to Light

This proposal brings innovation to the current management of supplies in the warehouse. This includes keeping records of incoming goods and delivery of stock, ensuring stock rotation using the First In–First Out method, and communicating the stock status, with the corresponding regular reports.

3.5 ABC Classification

The proposal is based on using the ABC inventory classification tool to group supplies according to their purchase value. In this way, the most valuable supplies can be prioritized by taking preventive and care actions. Such actions will be reflected in the supplies procurement policy raised in this research.

As mentioned previously, the model will be developed in the procurement process of the mentioned restaurant. For such a restaurant, we prepared a flowchart showing the activities performed from the planning stage to the control stage of the supplies stock. There are three agents directly involved in this process, namely, an external agent (supplier) and the two on-site agents (logistics assistant and kitchen manager).

On the contrary, there are three indicators that are relevant in the research:

The general indicator within the research and within the procurement process is the F&B cost indicator. This indicator measures the net sale percentage representing the supplies cost for preparing a product, in this case, for each unit. However, to get an overview of this indicator and its performance throughout the management of a restaurant, it can be calculated globally by dividing the purchase made in a given period by the net sale of the same period.

Another indicator within the procurement process is the purchasing variation. This is used to calculate what percentage of the budgeted purchase was exceeded or if it was

not. A negative result in this indicator would mean that the purchase was within the budget. This indicator is related to the A&B cost indicator, because if the purchases exceed the budget, i.e., the variation is very big, this will cause the A&B cost indicator to also increase. Therefore, this indicator must be controlled so that it does not affect the other indicator.

The purchase-based loss indicator, just like the previous indicator, is related to the A&B cost indicator. If there is more shrinkage or loss inside the warehouse or at the time of preparation, more supplies will have to be purchased to replenish the inventory stock. This would mean that at the end of the period, the A&B cost indicator will increase. With this indicator, the purchase percentage that represents the shrinkage or loss can be calculated. To calculate it, the financial value of the shrinkage or loss must be divided by the financial value of the purchase made in a given period and then be multiplied by one hundred. This indicator is calculated monthly within the company understudy and is expected to not be greater than 1%.

3.6 Validation

This section of the article will explain the validation of the contribution proposed in the previous section using the Bizagi Process Modeler software, which was considered an appropriate tool as it allows creating flowcharts for business processes and then simulating them.

In addition, it is important to mention that the period to be simulated will be one year and a thousand iterations will be made. The input variables will be the budget purchasing values for the 2019 supplies. The output variable will be the actual purchase of that same year. The entities in transit within the simulation will be the purchases made during the year.

It was ascertained that in the compliance checks of supplier shipments performed within the simulation, no orders were rejected because of poor conditions. On the contrary, there is only one non-compliance incident regarding the quantity of goods sent by suppliers.

When posting the existing loss, no entity entered that activity; therefore, there was no significant loss when applying the model within the simulation. Contrastingly, after performing the outbound check from the warehouse, it was necessary to make two additional purchases that were out of the budget, which means returning to the beginning of the process flow. Summarizing the results, 50 budgeted and 2 non-budgeted purchases were made throughout the year (Table 1).

Table 1. Simulation results after applying the model

	Model	
Financial value of each entity	S/. 23,183	
Entities generated in the simulation	50	S/. 1,159,134

(*continued*)

Table 1. (*continued*)

	Model	
Entities in loss/shrinkage	0	S/. –
Unplanned purchase entities	2	S/. 46,365
Real purchase		S/. 1,205,499

When calculating the financial impact of the model simulation results on the procurement process, it can be observed that when applying the model and using the information collected throughout 2019, the real purchase throughout that period was S/. 1 205 499. In other words, a more efficient purchase was made by comparing it with the current situation of the same year. After obtaining the results and validating them, a comparison will be made between the situation without applying the model and the situation after applying the model. This is done to thoroughly measure the impact of the proposal, and the indicators will also be analyzed before and after the proposal being implemented (Table 2).

Table 2. Comparative analysis of the current situation vs model

	Comparative analysis	
	Current situation	Model
Entities generated in the simulation	S/. 1,159,134	S/. 1,159,134
Entities in loss/shrinkage	S/. 23,183	S/. –
Unplanned purchase entities	S/. 92,731	S/. 46,365
Real purchase	S/. 1,275,047	S/. 1,205,499
Profit obtained	S/. –	S/. 69,548

By comparing both simulations and analyzing the overall results, it can be observed that applying the model resulted in a financial profit of S/. 69 548. This confirms that the proposed model, after being implemented in the procurement process, has a positive impact in economic terms (Table 3).

Table 3. Comparative analysis of the A&B cost indicator

	Comparative analysis of the F&B cost	
	Current situation	Model
Net sale of the year 2019	S/. 4,022,407	S/. 4,022,407
Real purchase	S/. 1,275,047	S/. 1,205,499
Food cost indicator	31.70%	29.97%

Regarding the proposed indicators, starting with the A&B cost indicator, it was determined that by comparing the information of the current situation with the results obtained, the indicator was reduced by 1.73%.

As for the purchasing variation indicator, once the model was applied, the said value was recalculated and compared with the initial diagnosis. The following result was obtained (Table 4).

Table 4. Comparative analysis of the purchasing variation indicator

	Comparative analysis of purchasing variation	
	Current situation	Model
Budgeted purchase Real purchase	S/. 1,183,100 S/. 1,275,047	S/. 1,183,100 S/. 1,205,499
Food cost indicator	7.77%	1.89%

It can be observed that this indicator was significantly reduced, dropping from 7.77% to 1.89%, which proves that purchases were made more accurately, and there was no need for unplanned purchases involving higher financial disbursements. In the last indicator concerning the shrinkage or loss depending on the purchase, according to the simulation, it was possible to reduce it completely, because as mentioned, no entity led to shrinkage or loss. However, the fact that the error occurs within a process is normal and common knowledge; therefore, comparing the last indicator is limited. However, it is shown that it is possible to reduce shrinkage or loss with the proposed model to an optimal reference level of less than 1%.

4 Conclusions

The synergy between SCM and lean philosophy has managed to establish a combination of tools that have contributed to optimally motivating and developing the purpose of this scientific article, besides solving issues encountered at the restaurant. Further, the F&B cost indicator of the gastronomic company under study was reduced by 1.73%. After the validation of the proposed model, the existing gap in the nominal cost of the menu (nominal A&B cost) was reduced.

The variation of actual purchases, with respect to budgeted purchases, was reduced by 5.88%; thus, in this way, the planning of future purchases will be more accurate and will be based on the company's real and available data.

The company was able to reduce the shrinkage and loss, because having more control over them and the shrinkage being reduced contributes to decreasing the main indicator as well as reducing the amount of supplies that are converted to waste. However, the financial impact of this indicator shows a clear limitation.

The proposed model will serve as a reference to different companies in the field, regardless of the type of kitchen that they focus on. By implementing the model, they will be able to achieve an optimal procurement process by reducing the errors within it.

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Production Planning and Control Model to Increase On-Time Deliveries Through Demand-Driven MRP and PDCA in a Make-to-Order Environment of Non-primary Manufacturing Industry

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Abstract. In recent years, production environments have gone from predictable to dynamic, therefore factors such as delivery time and a high percentage of customer satisfaction have become fundamental criteria for this new environment. Production planning and control (PPC) systems must be aligned with the new objectives of the manufacturers, however, the most popular PPC don't satisfy their needs. This is how this article proposes a PPC model based on the Demand-Driven MRP system supported by the stages of the PDCA cycle so that it can perform optimally in dynamic environments such as make-to-order manufacturing models. As a result of the simulation in the case study, 100% compliance with deliveries on time was obtained and a reduction in lead time by 50.33%. Therefore, it is concluded that the proposed model is applicable and beneficial in this context.

Keywords: Manufacturing · Delivery time · Make-to-Order · DDMRP · PDCA

1 Introduction

The manufacturing sector is an important part of the global economy. In 2018, this represented 16.82% of the world's gross domestic product (GDP) despite the fact that both emerging and advanced economies have been experiencing a decline in their manufacturing sectors [1, 2]. In Peru, this sector represents 16.52% of the national GDP; Likewise, the Manufacturing Production index registered an increase of 5.27% with respect to the previous year, which was due to the higher production of the primary manufacturing subsector by 24.08%, and to the increase of the non-primary manufacturing subsector by 0.06% [3]. To date, Peru has more than 2.5 million active companies, of which 212 thousand 674 belong to the economic activity of manufacturing industries [4]. Thus,

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 1209–1217, 2022.
https://doi.org/10.1007/978-3-030-85540-6_155

faced with the context in which the country is characterized by having as the dominant business stratum the SME, representing 99.5% of the companies, the constant concern arises to ensure that these develop and grow in a sustainable way in order to maintain the economic development of the country [5].

Today's manufacturing companies grapple with a business environment that places more emphasis on the concept of customer-oriented manufacturing. Therefore, a company that has the ability to fill customer orders quickly, as well as offer customized products, enjoys a competitive advantage and therefore a greater role in the market. In this context, the development of a production planning and control system plays a crucial role for manufacturing companies, which is why "in the literature you can find different systems developed in the last century, the most widespread being: (a) Materials Requirements Planning (MRP), (b) Just in Time (JIT) and (c) Theory of Constraints (TOC)" [6, 7].

2 State of the Art

2.1 Production Planning and Control Models in Non-primary Manufacturing Industry

In the non-primary manufacturing industry, three types of manufacturing environment are developed: Make to Stock (MTS), Make to Order (MTO) and Assemble to Order (ATO), the first two being the most common in the industry. However, in recent years part of the companies belonging to this industry have chosen to change from an MTS environment to the MTO [8–10]. This is due to the fact that they seek to avoid any inventory stagnation, obtain ease of adaptation to the real demand of the client while controlling the work in process (WIP) and provide a high level of service to the client against their needs, which time has undergone many changes thanks to the advancement of technology [11, 12]. In addition, it generates that orders are based on the client in a short and reliable cycle time and that deliveries on time become competitive factors of the MTO environment, while the MTS environment has as competitive factors the rate of performance and productivity [11, 13]. For this reason, models have been developed focused on the management of control and planning in the production process in order to allow companies to face the growth and uncertainty of demand [14, 15].

2.2 Demand-Driven MRP in Non-primary Manufacturing Industry Production Planning Models

The most widely used production planning management method is the integration of MPS and MRP. Both are aimed at companies in a push manufacturing environment. The first methodology aims to define demand forecasts based on historical data during a certain period, while the main objective of the second mentioned methodology was to plan the requirements of the materials. However, the latter suffered a series of limitations that were transformed into new applications according to levels [16–18]. These include closed-loop MRP, MRP II [16] and finally enterprise resource planning (ERP) and newly emerging supply chain planning systems [17, 18]. Furthermore, due to the limitations

presented by each one of them, researchers have studied various solutions for production planning focusing on the management of demand uncertainty. As a result, the research "Demand Driven Material Requirements Planning (DDMRP)" [19] presents the advantages and contributions of a new demand-driven planning method called DDMRP. These authors founded the Demand Driven Institute, which recently published its most recent success stories in companies in the manufacturing sector internationally during 2017 and 2018. However, in order to validate the usefulness and success of its application [8, 13], research has been carried out, which shows that the application of this tool generates positive results in the non-primary manufacturing industry.

2.3 DDMRP and PDCA in Production Planning and Control Models in Non-primary Manufacturing Industry

As mentioned in section A, the literature has proposed production planning and control models focused on a push system, which is why they are formed by the combination of MRP, MPS and variants [14, 15]. However, these are not focused on a pull system, that is, they are not driven by demand, which generates uncertainty and difficulties in companies to satisfy the current market. Therefore, certain authors have proposed and corroborated the effectiveness of the DDRMRP tool by dramatically reducing the delivery time of products [8, 13, 20], as developed in section B. Likewise, as stated mentioned in section A, certain authors proposed a model that links production planning and control with the PDCA methodology. This leads to effective and rapid improvements to solve problems without the need to invest a high implementation cost [20, 21], which becomes an advantage of high application value compared to other methodologies.

3 Input

3.1 Proposed Model

The design of the production planning and control model is presented in Fig. 1. This model takes as a reference the design of the four stages of the PDCA cycle to better organize and visualize the flow with which the modules should be carried out that comprise the model.

PLAN. This stage is made up of two modules. The first is focused on engineering design document management. This module seeks to preserve the veracity of the data provided by the design documents and thus mitigate possible incidents that may be generated in processes such as production and supply. The second module refers to the planning of production and its requirements. For this, the model proposes the use of the DDMRP system. The purpose of applying this system is to keep the company's purchasing and production calendar updated in order to preserve the admissible lead time ranges. In addition, the total components within this module were considered in order to guide companies that do not have the DDMRP system in their organization, to incorporate it by sequentially following the components presented.

DO. Within this stage are the modules of the purchasing and manufacturing processes, which are executed following the guidelines of the DDMRP system, that is, according to the levels of the buffers placed in each material and finished product as well as the value of its net flow, which is subject to the entry of customer orders. This in order to comply with the desired manufacturing cycle time of each product and not fall into delays or shortages of materials.

CHECK. The control module within this stage is divided into two. On the one hand, this is focused on the controls to be carried out by each work area used for the manufacture of products with the support of instruments such as checklists. Likewise, to control the correct operation of the DDMRP system, the use of reports on the behavior of buffers is proposed for each buffer used in the system. On the other hand, the module includes the audit section that seeks to ensure the results of the model by corroborating its correct application.

ACT. This stage includes the need to constantly improve the performance of the organization by correcting any defect or error. Likewise, it is proposed to carry out periodic training on the issues involved in the model; and effective periodic meetings between key members of the organization in order to detect improvement issues and/or corrections.

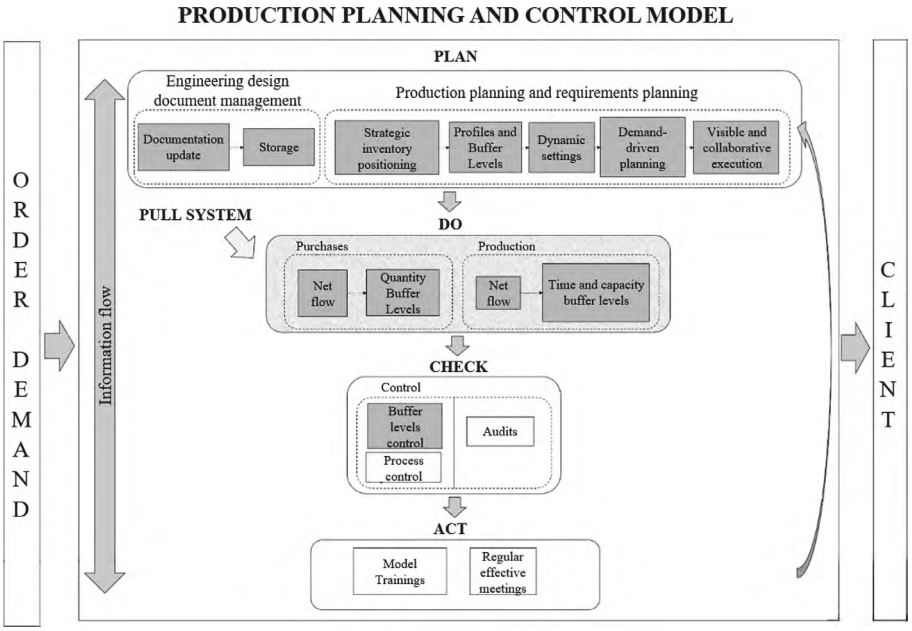


Fig. 1. Proposed production planning and control model

3.2 Start-Up

DDMRP. The implementation of this tool, with regard to the PLAN, DO and CHECK phases, contemplate the sequential implementation of the five components defined by [19]:

Strategic Inventory Positioning. This first component wishes to ensure the constant flow of relevant information in the supply chain and its correct protection by positioning decoupling points along the chain.

Buffer Profiles and Level Determination. This second component focuses on the design of the buffers to be used in order to achieve protection and independence from the decoupling points.

Dynamic Buffers. This component seeks to determine the measures to be taken to adapt the buffers to the changes that occur (such as the appearance of new suppliers and materials, new markets or deterioration of others, changes in capacities and manufacturing methods, etc.) and that affect to group and individual features.

Demand-Driven Planning. The fourth component of the DDMRP is Demand Driven Planning. Its objective is to generate a simple, intuitive and highly visible method of generating orders and orders, since it is based on the orders of the clients as a precise form of demand. This will provide the demand input into a daily planning equation for each decoupling position, this equation is known as the Net Flow equation.

Highly Visible and Collaborative Execution. What this component seeks is to manage the supply orders against the relevant criteria in order to ensure the continuity of the flow of the model. For this, the DDMRP model raises 2 types of alerts: buffer status and synchronization.

Checklist. The use of the checklists is carried out by both operators and managers. Thus, for the continuation of the product manufacturing process, the approval of the Plant Manager will be required. If this is not present in the plant at the end of the process, the approval of the Production Assistant, and, if the same happens, it will be approved by the Warehouse and Dispatch Manager.

3.3 Model Indicators

Indicator 1. On time Delivery (OTD): It is the percentage of products delivered at the time agreed with the customer.

$$OTD = \frac{deliveries\ on\ time\ in\ period\ N}{total\ deliveries\ to\ be\ made\ in\ period\ N} \times 100\% \tag{1}$$

Indicator 2. Purchase order cycle (Lead Time): The purpose of this indicator is to control the time that elapses between the moment the customer places the order and the moment he physically receives the merchandise.

$$LT = \frac{average\ order\ fulfillment\ time}{number\ of\ orders} \tag{2}$$

To obtain the Lead Time variation, it is necessary to first define the Manufacturing Lead Time, which assumes total availability of all materials.

$$MLT = \frac{order\ manufacturing\ time}{order\ quantity} \tag{3}$$

$$VAR_{LT} = \left(\frac{LT}{expected\ LT} - 1\right) \times 100\% \tag{4}$$

Indicator 3. Waiting time for materials (TEMP): It is the dead time that has elapsed due to the lack of materials necessary for the execution of a process.

$$TEM = Dead\ time\ between\ processes\ in\ hours \tag{5}$$

Indicator 4. Gross profit margin (MGB): It is the direct benefit that a company obtains for a certain product.

$$\%MGB = \frac{Sale - Cost}{Sales} \times 100\% \tag{6}$$

4 Validation

4.1 Case Study

The test scenario occurs in the production and supply areas of the company named, by confidentiality agreement, as "ABC, whose location is in Lima, Peru. This company is dedicated to the manufacture of high-end furniture under the Make-to-Order modality; Thus, the company "ABC" is classified as an SME belonging to the non-primary manufacturing sector. For the simulation, time studies were carried out, thus establishing probability distributions of the production processes, arrival of orders and arrival of materials for Product 1 of Collection 1, which represents 38% of the company's sales.

4.2 Initial Diagnosis

During the period under study, the company "ABC" delivered 36% of its orders late, where it was determined that 83.33% of the reasons that generated it were the dead time between processes caused by lack of availability of materials, while 16.67% of them were caused by reprocessing in the assembly stage. It should be noted that the current lead time for Product 1 is 12 days, while its MLT is 4.18 days, data that was obtained through the DDMRP tool.

Taking into account the aforementioned and the previously defined model indicators, an initial diagnosis of the case study was made, generating the results in Table 1.

Likewise, with regard to the economic impact that the present deficiencies cause in the company, a monetary loss of 99,135.00 soles was calculated during the period of one year.

4.3 Simulation of the Proposed Model

For the purposes of simulating the proposed model, the following has been carried out: the Plan phase, in what corresponds to production planning and materials requirement planning; the Do phase, both in the purchasing and production processes; and the Check phase, with regard to the projected reduction of reprocesses. To make the aforementioned effective, it was necessary to use the Arena software.

4.4 Comparison and Analysis of Results

To obtain results, 26 runs were considered, which is the optimal number of observations. These had a length of 20 days and a confidence level of 95%.

It should be noted that in the simulation a reprocessing percentage of 3.7% was considered, which represents the moderate or most probable scenario.

As a result, it was obtained that the accumulated waiting time for materials is 0.4152 s, the lead time obtained is 5.96 days and the percentage of fulfillment of deliveries on time is 100%.

Next, the results obtained are compared to the current values of the case under study.

Table 1. Results comparison

Indicators	Current values	Values obtained
OTD	64%	100%
VAR LT	191.26%	44.66%
TEM	97.38 h	0 h
MGB	45.36%	68.36%

As can be seen, the indicators defined above had positive results, which is why it is verified that the application of the proposed model is adequate for the solution of the identified problem. In addition, based on the values obtained, an income of 197 967.45 soles is projected for the company as accumulated savings in the two-year period.

5 Conclusions

The inclusion of demand-based MRP within a production planning and control model has been shown to provide a planning system managed by real demand as well as a visible execution system that allows planners to take the necessary actions on time real.

The proposed model would achieve 100% fulfillment of order deliveries on time for the simulated product in a pessimistic, moderate and optimistic scenario.

The current lead time of product 1 would decrease from 12 days to 5.96 days in the most probable scenario, that is, it would be reduced by 50.33%.

In relation to the current dead time due to lack of availability of materials, which was 97.38 h, it would be reduced in its entirety by applying the proposed model.

The gross profit margin of product 1 would increase from 45.63% to 68.36% in the most probable scenario, which shows its profitability.

An accumulated saving of 197,967.45 soles at the end of the 12-month post-implementation period.

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Building a Virtual Simulation Teaching and Learning Platform Towards Creative Thinking for Beijing Shahe Education Park

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Abstract. In response to China's innovation-driven development strategy. The course development team is developing a course on innovation and entrepreneurship education. The course guides students to break through their professional limitations and develop creative thinking from multiple perspectives and at a deeper level. The team breaks away from the previous "teaching and learning" pattern and combines virtual simulation technology to develop an online teaching platform. The team develops virtual simulation modules and designs immersive interactive teaching classes and scenes based on the existing creative thinking courses. Explore the application of virtual simulation technology in online teaching, building a new innovative co-construction pattern, co-management, and sharing of universities, scientific research institutes, and enterprises. Create a virtual simulation service support system with independent intellectual property rights, high market utilization, a wide range of applications, and realize the open sharing of educational resources.

Keywords: Virtual simulation · Creative thinking · Design thinking

1 Introduction

With the rapid development of science and technology, human beings have stepped into the information age, and the current knowledge content has an explosive growth trend. At present, the measurement standard for talents cannot be satisfied with the amount of knowledge, innovative thinking, creative ability, and so on have occupied an increasingly important position. Against this backdrop, China put forward the strategy of "innovation-driven development" in 2016. It clearly states that we need to "promote educational innovation, reform talent training mode, and train scientific spirit, innovative thinking, creative ability and social responsibility throughout the whole education process. "More and more innovative education has been carried out in universities and educational institutions.

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 1218–1226, 2022.
https://doi.org/10.1007/978-3-030-85540-6_156

When college students study online, their learning characteristics change. Due to teachers' lack of close supervision, students' autonomous ability and learning motivation will decrease when facing online learning [1]. Knowles and Kerkman also proved this view through pre-experiment and post-test [2]. Online education is an emerging field at the intersection of distance education, human-computer interaction, instructional technology, and cognitive science. As technology continues to evolve in college education, educators have acquired a host of Internet tools. They are beginning to allow for a shift like teaching in the teaching and learning process. With the launch of Coursera, edX, Udacity, and other mature foreign online education platforms, many online education courses have emerged and attracted much attention. Universities have begun to experiment with online learning courses, such as Connectivism and Connectivity (CCK08) offered by the University of Manitoba in 2008, Personal Learning Environments, Networks and Knowledge (PLENK2010) offered by the Institute for Technology Enhancement Knowledge at Athabasca University, Stanford University offered the course Artificial Intelligence: Principles and Techniques (CS221) for free in the fall of 2011, which attracted 160,000 registered students (Rodriguez, 2012). Higher and higher education institutions accept online education, and the number of students taking online courses is increasing rapidly in American universities [3].

Moore and Kearsley propose three stages of the development of e-learning: traditional correspondence and independent learning courses, the Open University in the 1970s, and the use of broadcasting and conferencing tools in conjunction with computers to enable learning, communication, and collaboration [4]. With the rapid development of science and technology, Keegan redefined the development stage of online teaching and proposed that distance learning, digital learning, and mobile learning are the three development stages of online teaching [5]. Leinhardt believes that there are two trends in applying online education in the field of education at present [6]. One is that online teaching is gradually combined with the daily practice of universities, and the other is that distance programs are gradually playing an increasingly important role in higher education institutions. For some, online learning offers an unprecedented opportunity to overcome the limitations of traditional classroom teaching. To others, online education may threaten the quality of existing education. Since the beginning of the 21st century, people's attitude towards online education has changed with the continuous development of technology. Zhou believe that online education has become one of the essential education methods [7]. Countries worldwide are actively exploring how to educate students through the Internet effectively. There are many good examples of online education, thus generating many valuable experiences in online education.

Gloria argued that online teaching is a more personalized learning environment, which puts higher demands on online teachers [8]. For many university teachers, the major challenge is that they lack the skills and knowledge needed for online teaching [9]. Moreover, the problem of students' concentration in online learning is also a key concern of teachers. Harasim points out that long text teaching cannot be carried out online, nor can the method of question and answer be used alone [10]. Students will not participate in it, and long periods of virtual silence will follow. Based on an analysis of a series of large-scale MOOCs offered by Stanford University, Anderson found that online courses have different student behavior habits and defined five different student

behavior categories [11]. Viewers (who watch lectures but rarely watch assignments), problem solvers (who do assignments but rarely watch lectures), omnipotent (who balance lectures and assignments), collectors (who download lectures frequently but may not watch lectures), and bystanders (who barely watch lectures after registration).

Furthermore, deploy a badge incentive mechanism to promote student participation and learning. Moore believes that there are three types of interaction in distance education: (1) The interaction between learners and learning content. (2) The interaction between learners and teachers. (3) The interaction between learners, among which the interaction between students, especially the collective interaction between students, is the most critical dimension in the three stages [12]. The ubiquity of collaborative learning has made students an essential part of each other's learning environment. Volery and Lord identify three critical success factors for online education: technology, teacher, and previous use of that technology on the student side, while the teacher will continue to play a central role in online education [13]. Garrison argue that interaction is a primary focus of online learning research [14].

The grand goal of education information is to the teenagers in our country, not the minority college students are trained with "innovative consciousness," "creative thinking, creative thinking," and "innovation" three aspects qualities of innovative talents, which can realize the great rejuvenation of the Chinese nation the actual contribution of talent [15]. Xu Yingqing stated that discipline crossing and design innovation means that more intelligent design thinking, design theory, design method, and design means need to be profoundly coordinated with increasingly intelligent theory and method to achieve the purpose of innovation [16]. Zhong Qiquan pointed out that the 21st century is an era of "knowledge society," in which the cultivation of "creative" learning power is not only the "memory-based" learning power of knowledge acquisition and reproduction but must be the "thinking" learning power of active learning [17]. As the essential points of students' core literacy, problem solving and technology application are the keys to enhancing national talents' core competitiveness in the 21st century. He Kekang proposed to explore the path of interdisciplinary integration, seeking the breakthrough of the development of educational technology discipline in the new era through collaborative project research, and pointed out that interdisciplinary is a component of the technological innovation cycle, bridging the gap between research, industry, and education [18]. With the development of this educational trend, more and more colleges and universities begin to pay attention to the practice and application of classroom contents and try to combine "brain-learning" with "hands-on production" in the teaching mode [19]. In order to cultivate innovative interdisciplinary talents and improve the core quality of college students, the school launched the optional practice course "Design Thinking" in 2019, which makes full use of the interdisciplinary advantages of each school and improves the design innovation ability and problem-solving ability of college students through the project-based learning mode of "Learning by Doing" [20]. As a globally recognized effective mode of cultivating innovative talents, design thinking course has influenced many Fortune 500 companies and launched related courses in many universities, including Stanford University [21, 22], Yale University, Harvard University, etc.

2 Related Work

Subverting teaching reform brought a series of complex bottlenecks, summarized as the following four aspects: (1) Creative thinking is included in the process. It is difficult to observe and perceive. Creative thinking is cultivated from 0 to 1 innovation process, which contains the same heart, definition problem, creative, prototype production, test five parts, which contains psychology and design knowledge. However, there are the link is that we are difficult to touch, just like a heart. The same is neither sympathetic, and it is impossible to let others feel the same. Therefore, traditional teaching methods have limited the profound understanding of the invisible psychological activities so that students are challenging to master the mental mechanisms behind others. (2) Many innovative ideas cannot be carried out in real contexts because of subject restrictions and environments. Creative thinking has always been people-centered. During this process, they studied "what kind of person" as one of the limited elements of the whole process. Some users need to customize creative thinking, but because such user occupations are limited, they cannot be studied in depth. Therefore, in traditional teaching, more tend to study through desktop research. This is not true and reliable. The integration of creative thinking is especially integrated. The environment on individual psychological processes is one of the important research contents of psychology. However, some scenarios involve some security factors and complex to carry out, such as driving vehicles. This kind of research often limits the development and subsequent evaluation of creative thinking, and it is not easy to carry out in teaching. (3) The blanks of science and technology hinder the innovation of thinking. With the development of science and technology, many creative thinking changes to actual landing products and technologies. However, the development of technology is far from the development of innovation, and the process of achieving creation is still relatively slow. Some techniques are expensive, precise, and vulnerable, limited in configuration, operational loss, and cannot meet the needs of students and multiple tests. Therefore, many creative thinking products have been contemplated due to technical reasons, which significantly hinder innovation and the cultivation of innovative talents. (4) There is good interaction in the existing teaching, but still, students are not adapted to open classroom environments. This course focuses on students interacting synergistic innovation. However, the students' psychology, personality is different, and there are still students shy to speak or even group discussions. The interaction is not high. This is a general problem in various courses.

3 Setting

Online teaching, as a new education model, is developing with the help of science and technology. From the perspective of domestic and foreign researchers, online teaching has been applied and practiced for a long time in foreign countries. Its theoretical system, case studies, and data support are all available.

We have developed the essential part of the creative thinking course based on students' self-drive, including the sorting of creative thinking content, the design and production of tools, and the technical support of innovative products. Vigorously develop virtual simulation project resources with creative thinking as the core. With virtual simulation technology as the medium, the project virtualizes the practice project, which is

lack of interaction due to abstractions, technology temporarily unable to be realized, and time and space constraints in the actual situation, so that students can carry out the operation and training of creative thinking in the virtual highly simulated environment. A management system for sustainable development has been established. The professional and echelon members of the course team are reasonably established, and the incentive and assessment systems are perfect. The teaching ability of teachers is enhanced through various professional pieces of training. The project will use the advantages of creative thinking teaching and virtual simulation experiment teaching from the above three perspectives using virtual and actual complementarity. Center now has a high level, advanced education concept of the experiment teaching team, the construction of the advanced, applicable, open the virtual simulation experiment teaching conditions, built a network of open platform, can give full play to the demonstration center demonstration radiation effect, to improve the teaching quality and improve the quality of the talents has crucial significance, It will contribute to the realization of high-quality resources of higher education in Beijing and promote the development and reform of higher education in China.

To comprehensively improve college students' innovative spirit and practical ability, the development of this project promotes the reform of innovative talent training programs and teaching reform in colleges and universities and establishes a teaching system that is conducive to cultivating students' practical ability and creative ability. We will build a resource-rich and distinctive general education course sharing platform to promote the sharing of high-quality teaching resources (Table 1).

Table 1. Progress and scheduling

Stage	Schedule
The first stage	• Improve virtual reality, enhance realistic laboratory conditions, deploy development environment development, and innovate virtual simulation courses software • Central teachers write virtual simulations, enhance realistic experimental scripts, communicate with the actual scripting of corporate external technicians, and start project development
The second stage	• Participate in virtual simulation related meetings, experience with domestic and foreign universities, central and innovative entrepreneurial space exchange • Teachers and technicians have initially completed virtual simulation and enhanced realistic experimental teaching project development • Participate in professional technical training, organize relevant learning activities
The third stage	• Teachers and technical personnel will further improve the virtual simulation and augmented reality experimental teaching projects, organize and carry out project tests, and improve and update the developed software

After implementing the project, it will become one of the crucial battlegrounds for teachers and students of the Department of Psychology to exchange and study innovation and entrepreneurship and cultivate innovative talents. It will also provide the visiting service of sharing teaching resources for the whole school, to play a good role of demonstration and radiation. The subversive reform of the curriculum will play a positive role in promoting the innovation and practice of teaching reform, the perfection of the teaching system, and the improvement of the teaching quality. This project has tremendous application significance for all universities in the university city, especially for science and engineering students. Under the background of "a new round of scientific and technological revolution and industrial reform, supporting service innovation and driving development," it provides more abundant teaching means to improve students' creative thinking ability.

4 Virtual Platform Design

To solve these problems, we can solve them through advanced immersion and interactive technology. The integration of virtual simulation, virtual reality, and augmented reality technology is undoubtedly an excellent supplement to this course and a critical path to strengthen practical teaching, improve teaching quality and cultivate high-end innovative talents. This project has tremendous application significance for all universities in the university city, especially for science and engineering students. Under the background of "a new round of scientific and technological revolution and industrial reform, supporting service innovation and driving development," it provides more abundant teaching means to improve students' creative thinking ability. (1) Based on the existing creative thinking course module, design and develop virtual simulation module, design and develop props and scenes of immersive interaction in each module. The current creative thinking course consists of five modules: Empathy, Defining Problems, Creativity, Prototyping, and Testing. Each module has its toolkit, which is conducive to classroom interaction and students' independent learning. Virtual simulation can simulate the scene and character psychology under empathy to improve the students' observation power and empathy. There are many user analysis and clustering tools in the definition problem, and the clustering process can be simulated using a virtual simulation system. In the prototyping process, virtual simulation can simulate many technical tools and production processes that are not available in the field and much-unrealized science and technology to improve the landing ability of the prototype significantly and improve the follow-up testing. (2) Exploring the use of virtual simulations in teaching in cooperation enhances the information provided by the computer system, adding users to the real world perceived technology, applying virtual information to the real world, and generating virtual objects, scenarios, or scenes generated by computer. The system prompts information to be superimposed into a real scene to enhance reality. Therefore, it is possible to use enhanced reality simulations to facilitate synergistic environments, enabling members in the collaborative process, and can overcome interactive in the atmosphere of collaboration. (3) The application of new technologies cannot be separated from the support of a professional technical team. In particular, the application of cutting-edge technologies such as virtual simulation, virtual reality, and augmented reality requires

powerful capabilities in 3D modeling, computer programming, server operation, and website construction. Therefore, a professional virtual experimental technical support team can be built. (4) Exploring the Sharing Mode of Virtual Simulation Experimental Teaching resources. It is hoped that with the support of this project, the new mode of co-construction, co-management, and sharing by universities, scientific research institutes, and enterprises will be explored. The sustainable development of virtual simulation innovative thinking teaching service support system will be built to realize the effective sharing of resources.

5 Discussion

With the popularization of "design thinking," educators gradually pay more and more attention to the education of prototype courses, including the rapid development of maker education, which makes the effective teaching mode become a research hotspot. Based on this study, this chapter hopes to conduct in-depth research from the following points in the future. (1) Exploring the generated proposal for developing the study of the development of the future inter-discipline line, there is a significant improvement effect, and can evaluate the course effect by introducing an index of the study participation, satisfaction, and other indicators. If the teaching conditions are allowed, it can also form three groups of students in this stage to adopt online teaching, offline teaching, mixed teaching, teaching research, assess teaching results, and output the best teaching plan. (2) Conduct in-depth research on the critical points of improving students' interest in online learning proposed by experts in the evaluation, discuss the interest trigger points of students in each module in the prototype design stage of online learning, take students' interest as the guide, improve students' learning effect and participation in class, and further improve the course link. (3) To discuss the conflict of insufficient knowledge of interdisciplinary students in the face of purpose-oriented solid prototype teaching, and explore the ways and methods to solve such conflicts through various studies, so as to help interdisciplinary students adapt to the learning pace faster and learn the critical and challenging knowledge in this stage better. (4) In addition to the prototype design stage course, consider other several stages from design thinking of study on online course teaching, and probes into the feasibility and effect of online teaching, so as to better achieve the effective spreading of the course online journal design thinking, let more students more efficient way to learn the knowledge through online learning.

The development of this project, to comprehensively improve college students' innovative spirit and practical ability, can promote the reform of innovative talent training programs and teaching reform in colleges and universities and establish a teaching system conducive to the cultivation of students' practical and creative ability. We will build a resource-rich and distinctive general education course sharing platform to promote the sharing of high-quality teaching resources. After implementing the project, it will become one of the crucial battlegrounds for teachers and students of the Department of Psychology to exchange and study innovation and entrepreneurship and cultivate innovative talents. It will also provide the visiting service of sharing teaching resources for the whole school, to play a good role of demonstration and radiation. The subversive reform of the curriculum will play a positive role in promoting the innovation and practice of teaching reform, the perfection of the teaching system, and the improvement of the

teaching quality. This project has tremendous application significance for all universities in the University City.

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System of Human Management Processes to Improve the Predictors of Staff Turnover in SMEs Dedicated to the Service Sector

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Abstract. Staff turnover is a consistent threat for companies, as the cost overrun generated by each rotated employee may be between 80% and 130% of an average salary. In Peru, small and medium-sized companies in the service sector have the highest turnover rate (19%). Therefore, it is necessary to strengthen the management of human talent within such types of enterprises and establish relevant mechanisms to curb or reduce the significant predictors of staff turnover. Thus, this paper proposes a system composed of three processes: Workload Distribution, Professional Growth and Development, Compensation and Rewards. For the conceptual validation, experts agree that the probability of success of the expected results of the system is greater than 75%. It can be concluded from this that the proposed system would reduce the probability of employees of SMEs in the service industry leaving the workplace.

Keywords: Human resource management · SME · Staff turnover · Workload distribution · Professional Growth and Development · Compensation and rewards

1 Introduction

Small and medium-sized enterprises (SMEs) generate 75% of the country's employment opportunities [1] and make a significant contribution to GDP. However, SMEs are facing various challenges and problems to stay current in the market. One of them is staff turnover, which has the greatest impact on the service industry. However, although this problem has a negative impact on the competitive performance of enterprises in the market [2, 3], small and medium-sized enterprises often lack human resource practices that reinforce employee retention.

This is because HR practices in SMEs are often reactive and short-term. In this regard, in order to provide an integrated solution, a human resource management process system has been proposed. Thus, it has been chosen to use a set of processes rather than a specific one, since it has been previously studied the positive effect of the integration of human resources practices compared to the application of individual practices [4]. Therefore,

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 1227–1234, 2022.
https://doi.org/10.1007/978-3-030-85540-6_157

the proposal involves three interrelated processes: workload distribution, employees' growth and development, and financial compensation and rewards.

2 State of the Art

Staff Turnover. For this research, staff turnover is understood as the resignation of a company's employees. According the reviewed literature, this problem is usually related to human resource practice [3, 4]. However, in an instance prior to the turnover itself, human management influences attitudes and behaviors related to work [2, 5]. Therefore, organizational commitment [2] and enterprise-employee relationship quality (E-ERQ) [5] are the main predictors of staff turnover. Regarding the former, Mathieu et al. [2] points out that the predecessor cause of this predictor was job satisfaction. E-ERQ, on the other hand, acts as a mediator between problems and organizational justice, which is its most important predecessor cause, according to Kim et al. (2017) [5]. Finally, regarding to its main consequences, staff turnover has a negative impact on the financial performance, productivity, and even the working environment of the enterprise [3].

Workload Distribution. Workload refers to the objective or perceived high work demands assigned to employees. However, in both cases, it is a predictor of burnout and has a negative impact on employees' perception of the company. On the other hand, the literature reviewed emphasizes the role of organizational justice in terms of workload. For example, Avery et al. [6] points out the importance of interpersonal dimension, since the employee is more likely to perceive greater workload, if he/she thinks that the boss is unfair in assigning tasks or determining delivery time [6].

Professional Growth and Development. Competency management model proposes human talent management based on employee performance. Therefore, competences are an attribute that employees can develop from progressive advances [7], which adds value to the enterprise. For this, human management practice must seek to have a positive impact on the attitude and behavior of employees. For example, advancement in the career line within a company helps to improve organizational commitment, having satisfaction as predecessor [8]. On the other hand, in terms of performance appraisal, this practice increases employees' perception of justice [9].

Compensation and Rewards. Monetary compensation is a part of human resource practices to improve employees' organizational commitment [10, 11]. However, in the process of compensation, employees' perception of "justice" is also very important, especially in terms of salary increase [10]. In this regard, the development of suitable compensation plans and policies is essential for organizations. Therefore, the starting point is the description and analysis of the company's position [12]. Subsequently, the evaluation of the positions is carried out, where the quantitative method is recommended since it is more objective [12]. Finally, the salary compensation structure is established.

3 Contribution

A system has been proposed as a solution tool to avoid staff turnover in SMEs in the service sector, given their dependence on human capital to achieve good performance. Therefore, considering the predictors of turnover intention and their predecessor causes related to them according to the literature reviewed, this paper proposes a set of three human resource processes: workload distribution, employee growth and development, and compensation and reward (Fig. 1).

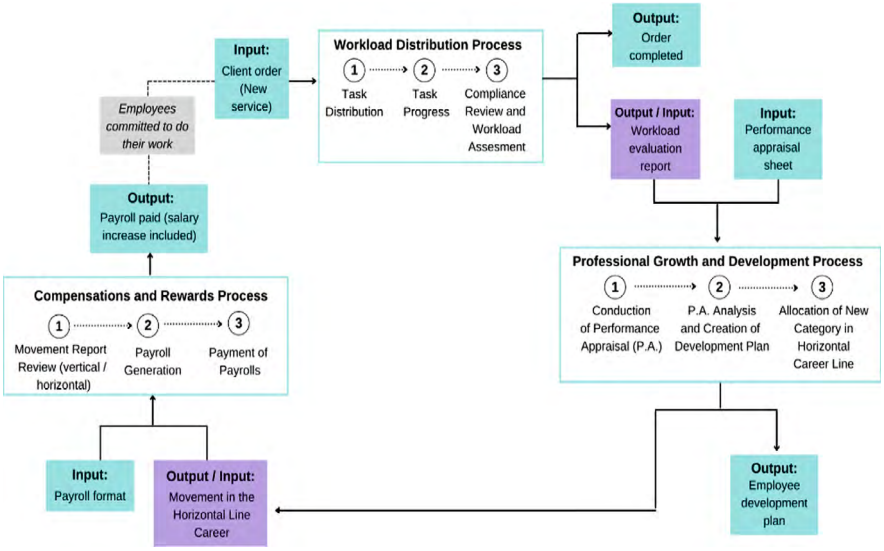


Fig. 1. Proposal for a human capital management system

3.1 Workload Distribution Process

Prework

Kanban Board is enabled in a common team space (physical or virtual) with the aim of making it accessible to all members. This board will have three columns: *To-do* (all the tasks that are pending), *Doing* (all in progress but not yet completed tasks), and *Done* (all 100% completed tasks). On the other hand, in order to adapt the use of Story Points, it is necessary to create an "effort scale", each level corresponds to a range of amount of determined workload and complexity.

Task Distribution

The working team will write the activities (broken-down task) in the cards. It should be emphasized that if the work cannot be broken down due to the nature of it, the whole activity will be replaced by the customer's order. In any case, team leaders need

to participate as mediators to balance the workload among employees. In the Kanban card in the "*To do*" column, it is recommended to put together the task description, the deadline to complete the task, and the effort to complete the activity (Story Points). In addition, when assigning the person in charge of the task/order, his/her name will be displayed on the Kanban Card to have visibility of the total workload shown on the Kanban Board.

Task Progress
When the task starts, the Card will go to the "*Doing*" column. To do this, a start date must be added to the card. In addition, the employee can put inside the card if there are any development blockers.

Compliance Review and Workload Assessment
It is validated the completeness of the task's deliverables and a report is made of each partner's workload assessment. The report will be based on the Story Points assigned to the employee over a period. In addition, this information will be an input for the overall performance appraisal.

3.2 Professional Growth and Development Process

Prework
Previously, companies must define the Horizontal Career Line (i.e. HCL) with a scale of categories that symbolize the degree of specialization, which can transversal to all positions or specific depending on the position. Therefore, it is recommended to have three to five categories of the HCL. Then the description of the requirements for each category is made according to the position. That is, it will be documented which skills/knowledge competencies (and the extent of these), achievements, and functions to fulfill in the role. In order to fully develop these aspects, it is recommended that at least a couple of notable differences be identified between one category and another. Finally, it is necessary to determine which category each employee in the company currently belongs to. Upon completion of these two prerequisites, a 360° Appraisal Sheet will be prepared, which is directly related to measuring compliance with the aspects listed in the job description sheets.

Conduction of Performance Appraisal (i.e. P.A.)
The 360° Appraisal Sheet is sent to the direct manager of the employee, the members of his/her team (peers), the people under his/her charge (if he/she has them) and himself/herself. This assessment measures the employee's performance in terms of responsibilities, technical skills and the extent to which he/she should perform within the competence of the current position. To do this, a score is assigned in each factor to be evaluated based on the performance shown. Thus, the current fulfillment of the position is reviewed.

P.A. Analysis and Creation of Development Plan
The HR manager receives the developed sheets and analyzes the results of each employee.

At this stage, workload reports should also be included for a comprehensive performance assessment. In addition, employees should be encouraged to create development plans based on the assessment findings. Thus, he will focus on honing his opportunities for improvement and, in turn, would aim to reach the next level in his horizontal career line (i.e. HCL).

Allocation of New Category in HCL
Finally, in case an employee has reached the requirements requested by the next category to which he/she is and presents a good or outstanding performance in his/her current position; he must be promoted in his HCL. For example, if the following category requires technical ability, knowledge and/or competence different from the current ones, it is evaluated at what level the collaborator has reached it.

3.3 Compensations and Rewards Process

Prework
Previously, the valuation of the jobs must be established. For this reason, in the first instance, the description of the jobs is considered, choosing only one of its categories as a reference. Therefore, in order to ensure an objective valuation, it is recommended to use the HAY GROUP method, which employs three basic factors (Skills, Responsibility and Problem Solving), which are developed by eight sub-factors in turn. In this sense, each job will get a partial score based on the intersection of these sub factors and a final score by adding the score of the three factors.

Once all the charges have been valued, it is necessary to create intervals, so that the number of scales and the extent of these can be identified. Likewise, it identifies to which interval each position belongs. Subsequently, the adjusted salary of the positions is calculated. To do this, a table must be created in which the name of the positions, their respective scores and current salaries are placed. Then, the equation of the line is calculated, where salary is the dependent variable (X) and the total score of the position (valuation) is the independent variable (Y). In this way, the adjusted salary for each position would be obtained, replacing the dependent variable. After making the adjustment, the compensation structure is created through salary scales. To do this, the maximum and minimum limit of each scale must be defined by multiplying the equation of the line by the factor ($1 \pm m$), where (m) is a constant percentage defined by the company. Subsequently, the minimum and maximum score of the scale replaces the dependent variable of the equation of the line to find the lower and upper limits respectively. Thus, the result is the minimum and maximum (adjusted) wages for each scale.

After obtaining the salary structure, each category of the HCL must be evaluated, taking as a reference the category used to carry out the first evaluation. Once the total score of each category by position has been quantified, the salary adjusted to the equation of the main line must be calculated and each category must be located within the corresponding salary scale. Finally, the company must formulate a salary policy that salary that salary

growth depends on changes in HCL. In addition, it is suggested to add other aspects, such as "rewards" for outstanding performance.

Movement Report Review
Considering the development from the preliminary stage to the process, the beginning of the process starts with the HR manager, who must review the movement report. If there are any organic (vertical) or category (horizontal) changes, the employee's information on the payroll will be updated to increase the compensation appropriately.

Payroll Generation
Then, the HR manager will generate the final payroll, which includes tax, benefits, among other concepts. Subsequently, the payrolls are submitted for approval.

Payment of Payrolls
Finally, once the payrolls are verified, they are sent to the area in charge of employees' payment.

4 Conceptual Validation

Regarding the expected results, the process of Work Distribution is considered to have a positive impact on organizational justice. Therefore, this result is assumed, since the use of Kanban Board and Story Points would allow perceiving a more equitable workload distribution. Also, the Growth and Development process is expected to contribute to increasing employee satisfaction levels as they may distinguish greater interest on the company in providing opportunities for their professional development. In addition, it is expected that, specifically, the 360° Evaluation tool positively impacts the perception of organizational justice due to a greater objectivity obtained through the points of view of more evaluators. Finally, the Compensation and Reward process is also expected to increase job satisfaction through the salary scales, since these clearly show the potential remuneration aspirations of employees. Likewise, a higher perception is estimated regarding the level of organizational justice for salary increases, since movements in the horizontal career line will be taken as reference.

To carry out the conceptual validation of the proposed system, the expert judgment technique was used. Thus, 4 experts in human resources management (national) and 4 potential users were summoned, that is, general managers of service SMEs or HR managers of these. To do this, a matrix was made with the expected results mentioned previously. In this, each expert scored on a scale from 0% to 100% (1 to 5 points), where the minimum value meant that the expected result was "Not likely"; whereas, the maximum value meant that the expected result was "Totally probable".

Next, Fig. 2 shows the consolidated results obtained after the evaluation of the eight experts. They agree that the probability of success of the expected results of the system is greater than 75% (4 points on average). Based on this conceptual validation, it could be affirmed that each process of the proposed system will have a positive effect on laboral satisfaction and/or organizational justice. Thus, it will influence on organizational commitment and enterprise-employee relationship quality too.



Fig. 2. Expert validation results

5 Conclusion

It is concluded that staff turnover is an important problem that affects companies' performance. In addition, it is possible to affirm that the administration of human resources affects work attitudes such as satisfaction and the perception of organizational justice. In turn, these factors are considered the root causes of the predictors associated with staff turnover according to the authors consulted for this study. For this reason, a human management system was proposed consisting of three processes: Work Distribution, Growth and Development, and Compensation and Rewards, which sought to positively impact both factors. Thus, for the conceptual validation of the system, eight experts were surveyed who agreed that the expected results of the processes were "very likely", which would increase the organizational commitment and the quality of the employee-enterprise relationship.

In this way, it can be said that the system has been approved for its implementation and has "optimistic" perspective, since it would generate benefits in the companies in which they are applied. That said, it is important to mention that the system can be adapted to different SMEs in the service sector. Finally, it is recommended that companies carry out an annual evaluation to observe the levels of job satisfaction and organizational justice that they perceive from their employees, in order to obtain historical data and, in addition, identify those small gaps that may exist in the development of the system.

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Youth Policy: From Educational Subject to Scientific and Practical Developments

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Abstract. The article highlights the academic and applied aspects of youth policy development in higher education institutions. The authors analyze the experience of the Faculty of Social and Psychological Education of Pavlo Tychyna Uman State Pedagogical University according to the educational and methodological support of educational subjects "Social Youth Policy", "Social Policy", "Youth Work".

Keywords: Social policy · Youth policy · Social work · Youth work · Youth · Scientific activity · Higher education · Scientific institutions

1 Introduction

Nowadays there are several urgent issues related to the preparation and formation of future youth policy makers' professional qualities. In particular, the practice shows the insufficiency of the existing forms of professional training, which today are mainly limited by the academic training of specialists in the social and socio-pedagogical spheres in higher education institutions. There are many demands to increase the effectiveness of social work with young people, including updating the training content, focusing on awareness of the experience of past years; taking into account the young people's age characteristics and rights, the formation of skills in choosing the content of work, planning, etc. Therefore, the formation of a truly socially competent organizer of youth work, development of effective models and training mechanisms for this area of social work, taking into account the appropriate features of the time orientations and interests of youth as well as the socio-political situation in the country and the world are in priority.

The state youth policy in Ukraine on youth work, education, socio-political and economic spheres, development of youth's spiritual, cultural and physical potential, youth organizations functioning, etc. is determined by legal documents, such as Laws of Ukraine "On Promoting the Social Formation and Development of Youth in Ukraine" (1993, as amended), "On Youth and Children's Public Organizations" (1998,

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 1235–1241, 2022.
https://doi.org/10.1007/978-3-030-85540-6_158

as amended), "On Social Work with Children and Youth" (2001 p., as amended); the Concept of the State Target Social Program "Youth of Ukraine" by 2021–2025 (2020); the Strategy for the development of state youth policy by 2030; the draft Law of Ukraine "On Youth" (2015); the State program "Youth Worker" and others. [3, 4, 5, 13], [15].

2 Analysis of Theoretical and Empirical Research

National and foreign scientific and practical, scientific and methodical works present the problem of youth policy development in various interdisciplinary studies, namely: the role of science in the formation of rational public policy in the youth sphere (M.M. Potapenko, I.V. Pesha); academic and applied aspects of research in the field of youth policy (E.I. Borodin); the role of scientific research and scientific support in national-patriotic education (O.O. Kravchenko, N.M. Koliada, Zh. V. Petrochko); the importance of scientific research in the training of specialists who work with youth (R.H. Vainola, N.V. Levchenko); youth initiatives in the field of social work, the creation of student social services (N.F. Romanov); soft skills of youth's scientific work (N. P. Pavlyk); development of the national state youth policy in the conditions of decentralization (O.Y. Yarema, A.S. Ostrikova), etc. [1, 6, 7, 10, 12, 14].

The purpose of the article is to highlight the academic and applied aspects of youth policy development in higher education institutions (from the experience of the Faculty of Social and Psychological Education of Pavlo Tychyna Uman State Pedagogical University).

3 Main Material Statement

State youth policy is "a systematic activity of the state in relations with the individual, youth, youth movement, carried out in the legislative, executive, judicial spheres and aims to create socio-economic, political, organizational, legal conditions and guarantees for life self-determination, youth's intellectual, moral and physical development, the realization of its creative potential both in own interests and in the interests of Ukraine" (Declaration "On General Principles of State Youth Policy in Ukraine", December 15, 1992, as amended) [3].

The development of youth policy at Pavlo Tychyna Uman State Pedagogical University has academic and applied aspects and has been changed from an educational subject to scientific and practical developments. First of all, it is the development of educational and methodological support of the following educational subjects: "Social Youth Policy" (in the context of the introduction of Bachelor degree specialists training in the speciality "Social Pedagogy", 2002); "Social policy" (in the context of the introduction of training Bachelor degree specialists training in the speciality "Social Work", 2011); "Youth Policy" (in the context of the introduction of training of OS Master degree specialists training in the speciality "Social Work. Youth Work", 2018) [14]. Eventually, in the context of the development of youth policy as an educational subject, there is a vital need to research in this area. Initially, there were studies on the youth work history: N. Koliada (Socio-pedagogical principles of children's movement development in Ukraine (early 20th - mid-30s of the 20th century, 2013); O. Kravchenko

(Educational and cultural activities of Proletcult in Ukraine (1917–1932), 2017); Yu. Klymenko (Socio-pedagogical principles of the Esperanto movement development in Ukraine (late 19th – the mid 30s of the 20th century, 2018); L. Grebin (Organizational and pedagogical principles of the orphanage in the education system of Ukraine (20s – the mid 30s of the 20th century), 2014); T. Duka (Historical and cross-cultural activity of the pioneer organization of Ukraine (60s of the 20th century), 2015); N. Levchenko (Training of children's movement organizers in Ukraine (20s–30s of the 20th century), 2015); I. Karpych (Problems of children's movement in the pedagogical periodicals of Ukraine (20 - early 30s of the 20th century), 2015).

Subsequently, the historical and pedagogical vector of research was expanded with scientific research on the theory and practice of social work, including youth work: N. Levchenko (Theoretical and methodological foundations of future social workers training for youth work); O. Baldyniuk (Educational activities of youth public associations of Ukraine (20s–30s of the 20th century)); E. Panchenko (Formation of leadership qualities of school-age children and youth in the system of non-formal education in the United States, 2019); A. Taran (Preparation of future social workers for the use of training technologies); O. Polishchuk (Formation of social and psychological readiness of high school students to enter higher education institutions); V. Boiar V (Formation of a responsible attitude to health in children and youth in the community); A. Voitovska (Gender socialization of student youth with special educational needs in the higher educational institution, 2020); M. Skochko (Organizational and conceptual principles of providing social services in rural areas); I. Molochenko (Organizational and conceptual principles of providing social services to people with disabilities through inclusive tourism); Yu. Pesotska (Social rehabilitation of children and youth with special educational needs through museum pedagogy); O. Verbovska (Professional rehabilitation of people with disabilities in a rehabilitation centre); S. Gorbenko (Ensuring equal access during the professions acquisition in the context of comprehensive rehabilitation of people with disabilities), etc.

Special attention should be paid to scientific research in the field of youth work, youth policy within the educational and scientific program "Social Work" of the third (educational and scientific) level of higher education (speciality 231 "Social Work", educational degree "Doctor of Philosophy") as well as the scientific program "Theoretical and methodological bases of preparation of future social workers for youth work" (speciality 231 "Social work", scientific level "Doctor of Sciences") [11]. Simultaneously with the preparation of dissertations, research in the field of youth policy is conducted in the context of the implementation of the following scientific topics:

- state budget topic "Development of the children's movement in Central Ukraine (second half of the 19th–20th centuries)" (basic research, state registration number 0110U001000, 2010–2012);
- state budget topic "Pedagogical and educational activities of public organizations of Ukraine (second half of the 19th – early 20th centuries)" (basic research, state registration number 0113U000331, 2013–2015);
- state budget topic "Socio-psychological rehabilitation of children and youth with special educational needs through inclusive tourism" (basic research, state registration number 0119U103978, 2020–2022);

– scientific topic of the Department of Social Pedagogy and Social Work "Actual problems of historical and pedagogical knowledge" (state registration number 0111U009198);
– scientific topic of the Department of Social Pedagogy and Social Work "Actual problems of socio-pedagogical theory and practice" (registration number 0111 U 00 75 47) [9].

There are some research structures of the Faculty of Social and Psychological Education of the Pavlo Tychyna Uman State Pedagogical University which are currently working on the development of topical issues of social work and youth policy such as Research Centre for Pedagogical Country Studies of the Double Subordination of the National Academy of Pedagogical Sciences and the Ministry of Education and Science of Ukraine; Centre for Social and Educational Integration and Inclusive Rehabilitation and Social Tourism "Without Barriers"; Gender Centre; Scientific and practical centre of family education; School of Best Practices "School of Social Knowledge"; Innovative project National-patriotic camp "Action" for student youth; etc. [9]. Over time, in the context of the development of academic and applied research, popularization of youth work in Ukraine, there was a need to identify a separate area of research, and therefore to identify a structural unit.

Youth work is a set of youth policy activities aimed at young people and conducted together with young people and for young people through non-formal education in their free time, aimed at enabling young people to develop independently. These measures are also aimed at improving the conditions of personal and social development of young people following their needs and capabilities, they promote their spiritual and physical development (draft Law of Ukraine "On Youth") [13]. Therefore, to implement the latest mechanisms of formal and non-formal education within the higher education institution the Youth Centre "Start" was established on July 19, 2018, at Pavlo Tychyna Uman State Pedagogical University [8]. The purpose of the Centre is to create conditions for the comprehensive development and self-realization of young people in various spheres of public life, for the disclosure of potential, protection of interests and rights; for promotion of social formation and development, professional orientation and organization of meaningful leisure, support of talented youth. The participants of the Centre are teachers and students of the university, pupils of the region [8].

The main results of the activity of Youth Centre "Start" include the implementation of basic and applied research in practice and the educational process. There was a start of training of youth workers for the educational and professional program "Social Work. Youth work" (educational degree "Master"); preparation of dissertation research for the degree of Doctor of Philosophy and Doctor of Science in the speciality 231 Social work [8]. Nowadays Youth Centre "Start" is the organizer of many events, including a set of training on the creation of Startup-projects; a program of masterclasses from successful youth leaders; information and practical course "School of Ladies and Gentlemen"; cognitive-motivational course "School of Youth Initiatives" for Uman schools' students, November-December 2018, the program "Youth. Education. Politics" (2020) and others [8].

On December 17–19, 2018 the Basic training of the National training program "Youth Worker" was held at the initiative of the participants of the Centre based on Pavlo Tychyna Uman State Pedagogical University [8].

Youth work is aimed at providing opportunities for the development of young people, their independence and autonomy; for the organization of healthy and safe leisure and rest of youth; for empowering young people to change situations that they believe should be changed in their immediate environment and society; for helping young people to interact with the authorities and politicians to create opportunities for young people to be involved in non-formal education, which contributes to the development of their competencies [13]. That is why youth work is considered to be an effective means of formal and informal civic education, which includes teaching young people how to live in a modern state, how to abide by its laws, but at the same time not to allow the government to violate their rights, how to demand their legitimate needs and to be a citizen of a democratic society.

An example of this is the program of personal and professional development of student youth "Youth. Education. Policy" (2021), aimed at creating conditions for personal and professional development of student youth in higher education following the State target social program "Youth of Ukraine" for 2021–2025. The program included 4 modules: personal and professional development; teamwork; social development; practical experience. Each of the modules was aimed at the personal, social and political development of the individual. Students of the Faculty of Social and Psychological Education, the Faculty of Preschool and Special Education became active participants of the program [2]. Within the framework of the Centre's activity, cooperation and experience exchange with youth centres from other regions and cities of Ukraine, as well as establishing international cooperation with leading European countries in the field of youth work. The official opening of the Centre took place on February 12, 2020. I.V. Pesha, Candidate of Pedagogical Sciences, Associate Professor, Director of the state institution "State Institute of Family and Youth Policy" was among the honoured guests of the event.

To promote scientific developments, practical experience in 2018, the university became the founder of the scientific journal "Social Work and Social Education" (srso@udpu.edu.ua). Since 2020, the journal has been included in the List of scientific professional publications of Ukraine of category B (order of the Ministry of Education and Science of Ukraine from 26 November 2020 № 1471), which can publish the results of dissertations (231 - Social work; 011 - Educational, pedagogical sciences; 015 - Professional education; 016 - Special education). Since 2019, the editorial board of the magazine has launched a new column "Youth Work" [6].

4 Results

Integration of education and science is a necessary condition for the innovative development of society. In the context of the abovementioned, the integration of education and science in the conditions of higher education, cooperation of free educational institutions with scientific institutions becomes relevant and vital. The cooperation of the Faculty of Social and Psychological Education of Pavlo Tychyna Uman State Pedagogical University with scientific institutions aimed at ensuring the innovative development of the

educational sector, in particular, higher education institutions and their research units, is a significant contribution to the integration of education and science. There are several scientific institutions with which the scientific and pedagogical staff of the faculty have established effective cooperation. They are the State Institute of Family and Youth Policy; Institute of Pedagogy of the National Academy of Pedagogical Sciences of Ukraine; Institute of Problems of Education of the National Academy of Pedagogical Sciences of Ukraine; Ukrainian Scientific and Practical Centre for Practical Psychology and Social Work of the National Academy of Pedagogical Sciences of Ukraine; Research Institute of Labor and Employment, etc.

In particular, the cooperation of the Faculty of Social and Psychological Education of Pavlo Tychyna Uman State Pedagogical University with the State Institute of Family and Youth Policy is expanding every year and is diverse. It includes review of educational programs, which train specialists at the Faculty of Social and Psychological Education of Pavlo Tychyna Uman State Pedagogical University; participation in the educational and research project "Women in the history of social work", the result of which are two collective monographs ("Women in the history of social work" (2018); "Women in the history of professional social work: from the 19th century to the present" (2020)); participation in the preparation of a foreign collective monograph "Social and educational services for people with disabilities: history, theory, practice" (2020) (I.V. Pesha "Risks of rejection of youth from social life"); joint holding of the Regional Round Table "New Ukrainian School: "soft-skills" through the prism of psychological and socio-pedagogical support of participants in the educational process" (February 2020); participation in surveys conducted by the Institute, and taking into account the generalized results of the survey in outlining the future activities of the University as a Centre of the youth community.

Thus, one of the main tasks of a holistic social policy is to create and provide real conditions for the comprehensive development of every young person, his full involvement in the political, socio-economic and spiritual life of society. The task of higher education is to actualize the multifaceted problem of youth work as a strategic direction of social policy at the academic and applied level, the development of research in the training of specialists in youth work and more. In the context of the above prospects for further research in this area is the justification of the role of science in the formation of sound public policy in the youth field, the role of research and scientific support in national-patriotic education, the importance of research in training youth workers, etc.

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Youth Work in a Higher Education Institution: Formation and Prospects of Development

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Abstract. Modern trends in the development of Ukrainian society have brought to the forefront of public life the problem of citizenship - both as a quality of society and as a quality of an individual. The development of democracy is inextricably linked to increasing the level of citizenship of society in general, and young people in particular. The problems of young people are always in the center of attention of teachers, public figures and politicians. The purpose of the study is to theoretically substantiate the features of youth work in a higher education institution (from the practical experience of the youth center "START"). Research methods: theoretical (systematic, normative-legal analysis of sources, content-analysis of documentation on youth work); empirical (quantitative - questionnaires, surveys; qualitative - conversation, structured interview to determine the level and needs of student youth).

Keywords: Youth · Youth work · Youth center · Institution of higher education

1 Introduction

According to the National Youth Strategy until 2030, it is determined that youth is an important subject of public policy. Today, youth policy is actively implemented at the regional and local levels, work with youth in local communities is carried out, youth participation in decision-making processes is expanding, youth centers of various levels (including the state institution "All-Ukrainian Youth Center"), youth advisory bodies, the national competition "Youth Capital of Ukraine" was launched, numerous programs, competitions and projects for self-realization and sustainable development of youth, the program "Youth Worker" is implemented.

The National Youth Strategy until 2030 envisions the introduction of new approaches to youth development in Ukraine, takes into account important aspects envisioned by the Sustainable Development Goals of Ukraine until 2030, youth strategies and documents regulating the principles of UN youth policy, the Council of Europe and the European Union. as well as demographic, security and economic challenges.

The purpose of the Youth Center "Start" is to create conditions for the comprehensive development and self-realization of young people in various spheres of public life, the

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 1242–1249, 2022.
https://doi.org/10.1007/978-3-030-85540-6_159

disclosure of its potential, protection of interests and rights; promotion of social formation and development, professional orientation and organization of meaningful leisure, support of talented youth. The participants of the Center are teachers and students of the university, students of Uman and Uman district.

Among the main results of the Youth Center "Start": the implementation of basic and applied research, implementation of their results in practice and educational process.

2 Literature Review

In Ukraine, according to the Concept of civic education (upbringing) of the individual in the development of Ukrainian statehood (National Academy of Pedagogical Sciences of Ukraine 2000), civic education is teaching people how to live in a modern state, how to follow its laws, but also how not to allow the authorities to violate rights of the people, to demand from the state realization of their legitimate needs, how to be a citizen of a democratic society. This approach, according to researchers, divided the concept of civic education as education and civic education as a "formal education" focused on acquiring knowledge and skills related to the rights and responsibilities of a man, a citizen [1].

The next step in building a civil society, the development of civic education - the adoption of the Law of Ukraine "On Education" (2017), according to which the concept of civic education has received a normative definition: "… the state must create conditions for civic education aimed at formation of competencies related to the realization of a person's rights and responsibilities as a member of society, awareness of the values of civil (free democratic) society, the rule of law, human and civil rights and freedoms" [2]. With the adoption of the new law on education, the concept of civic education has received a normative definition.

A new approach to civic education was proposed in the National Strategy for Civil Society Development for 2016–2020, which provides for the intensification of comprehensive measures aimed at improving civic education to protect their rights and interests through various forms of participatory democracy [5].

The lack of a unified approach to determining the content of civic education leads to the lack of a comprehensive system of civic education and creates a dispersion of civic education activities, uncoordinated actions of stakeholders. Starting in 2018, civic education is centrally implemented in general secondary education institutions, which makes general secondary education a platform for testing in the field of civic education. At the same time, activities at other types and levels of education take place mostly with the initiative or support of civil society organizations [5].

Domestic researchers and practitioners (a. Borenko, A. Honcharuk, V. Davydova, Y. Derkach, S. Zinchenko, O. Ogienko, T. Semigina, N. Pavlyk, etc.) single out a whole range of problematic issues that confirm the relevance of the organization of training of future non-formal education specialists in Ukraine. Among others - the lack of systematic research on the potential of non-formal education for the training of future professionals; lack of theoretical and empirical research on the basic provisions of the organization of non-formal education; insufficient use of innovative technologies for the development of social, personal and civic competencies of student youth, etc.

The state of civic education determines the insufficient efficiency of the development of civic competencies at all levels of education and in accordance with the important

public tasks defined by the state in the Concept of the development of civic education in Ukraine. Stimulation and support of civic education requires state support and its Development Strategy (draft Strategy for the Development of Civic Education for the period up to 2022, 2019) [6].

At the same time, non-formal education plays an important role in the implementation of modern educational tasks in general and the development of civic education in particular, which assumes corrective and compensatory functions, and therefore has a significant role in the training of future professionals.

However, non-formal education in Ukraine is developing unsystematically, which objectively determines the expediency of understanding and creative use of progressive ideas of domestic and foreign experience.

At the European level, the following documents are used, which are aimed at the institutional field of confirmation of professional qualifications acquired through non-formal learning, involvement of various public sectors and implementation of coordination mechanisms: "European guidelines for recognition of non-formal and informal education" (2009); Council of Europe Recommendations on the Recognition of Non-Formal and Informal Education Outcomes (2012), Recommendations of the European Center for the Development of Vocational Education (CEDEFOP) on the Recognition of Non-Formal and Informal Learning (2017), EU Council Recommendation on the European Qualifications Framework life (2017). In European countries, a diversified practice of confirmation and assignment of professional qualifications on the basis of non-formal learning has been formed. An important role in the process of confirmation of qualifications is played by professional associations and business structures, on the basis of which qualification centers (assessment centers) operate. At the same time, the recognition of the results of non-formal education and confirmation of professional qualifications takes place according to the same standards as for formal education and taking into account the national qualifications framework (T. Semigina) [10].

A clear confirmation of the important role of non-formal education for the development of civil society is the project "Promotion of civic activity through non-formal education", organized by the Association of Further Education and Training (Belarus) and NGO "Other Education" (Ukraine). The main goal of the project is to review the situation with civic education in Ukraine, based on the interpretation of the term education for democratic citizenship by the Charter for Education for Democratic Citizenship and Human Rights Education: "Education for democratic citizenship means education, training, educational, informational, practical activities and active actions aimed at providing learners with knowledge, skills and understanding, as well as the formation of models of behavior and values in terms of exercising and protecting democratic rights and responsibilities as a member of society, appreciate diversity and play an active role in democratic life to support and the protection of democracy and the rule of law" [1].

Domestic and foreign researchers determine the significant potential of non-formal education for the development of leadership qualities, civic values of youth; the role and place of non-formal education in the process of stimulating civic responsibility, implementation of social policy, democratization of society; development of civil society by involving local communities in social dialogue, personal development and self-realization.

This confirms the relevance of the thesis on one of the conditions of the civic education system - promoting cooperation between the spheres of formal and non-formal education (draft Strategy for the development of civic education for the period up to 2022, 2019) [5].

Among the main programs and providers of non-formal education, researchers and practitioners distinguish the following: The National Human Rights Program "Understanding Human Rights" (provides comprehensive human rights training and mentoring for activists, teachers, youth, journalists and other target groups); NGO Studena (conducts programs on social adaptation of veterans, gender equality and cultural development based on gender equality and non-discriminatory approach); NGO "Other Education" (conducts informal training programs and seminars on civic activism, critical thinking, dialogue, local history and activation of rural youth); Ukrainian Leadership Academy (a curriculum for young people with general secondary education aimed at personal development and social leadership and supported by international and Ukrainian donors, politicians and public figures); National Youth Worker Program (a training program for youth workers conducted by the Ministry of Youth and Sports in cooperation with UNDP and aimed to provide a training basis for working with young people in accordance with the European Competence Framework); the British Council's «Active Citizens» program (a social leadership training program that promotes community-led social development, provides workshops and small grants for groups that have initiated social change in communities) [1].

According to the analysis of current practice, many providers work at the local level with specific issues of civic education, building on existing programs or developing their own. Among others - local and regional NGOs, including youth and students, which hold outdoor events, festivals, forums and seminars, as well as use new coworking centers and/or libraries [1].

In the context of this issue, the practical experience of domestic higher education institutions in the implementation of effective means of non-formal civic education deserves attention.

3 Materials and Methods

In Ukraine, the main aspects of social youth policy, training of relevant personnel are regulated by legislation, regulations, namely: the draft Law of Ukraine "On Youth" (2015), the Law of Ukraine "On Promoting Social Formation and Development of Youth in Ukraine" (1993), as amended), Resolution of the Cabinet of Ministers of Ukraine "On approval of the State target social program" Youth of Ukraine "for 2016–2020". (2016), National Youth Strategy until 2030 (2021), Law of Ukraine "On Basic Principles of Youth Policy" (2021), Order of the Ministry of Youth and Sports of Ukraine "On Approval of the Procedure for Implementation of the Youth Worker Program" (2018), Law of Ukraine "On Higher Education" (2014), "Youth Worker" Program (2014), Resolution of the Cabinet of Ministers of Ukraine "On Approval of Standard Regulations on the Youth Center and on the Expert Council at the Youth Center" (2017), draft regulation "On Training of Youth Workers" (2017) and others.

In 2014, due to the urgency of disseminating youth work in Ukraine with the support of the United Nations Development Program of Ukraine, the Youth Worker program was

launched in cooperation with the Ministry of Youth and Sports of Ukraine and the State Institute of Family and Youth Policy. The implementation of the Youth Worker Program in Ukraine is a unique opportunity to raise the professional level of civil servants and public associations working with young people. This will increase the number of young people involved in youth policy-making and strengthen the interaction of state and youth public institutions in the field of the social development of youth at the national level.

Public authorities in Ukraine support youth professionals and regulate their powers and actions through the draft Regulation on the Training of Youth Workers (2017), which must be approved by the central executive body for youth. The regulation provides for the establishment of an expert council for the development of youth work, which is formed of competent representatives of youth organizations and considers and approves standard programs and standards for assessing the quality of training of youth workers; determination of criteria for certification by the national expert council of coaches of youth work of institutions and organizations that have the right to train youth workers; maintaining a register of certificates of youth workers who have successfully completed training in accordance with the requirements of this Regulation.

Since 2016, Ukraine has been training under the Youth Worker curriculum. After graduation, all participants receive state-standard certificates (State Institute of Family and Youth Policy). During 2017–2018, the issue of creating youth centers and expert councils on youth work at the regional and local levels is being addressed. In 2020, the All-Ukrainian Youth Center was established in Kyiv.

For the first time in Ukraine since 2018, the educational and professional program "Social Work (Youth Work)" has been developed and implemented at the Faculty of Social and Psychological Education of Pavlo Tychyna Uman State Pedagogical University, which aims to prepare masters of social work, social workers and youth work professionals. For one year and four months, applicants study disciplines of specialty 231 Social Work, competencies of which are provided by the State Standard of Higher Education "Master" and disciplines of youth work "Theory and Practice of Youth Work", "Youth in the Modern Community", "Youth Policy" etc.

In order to implement the latest mechanisms of youth work within the institution of higher education at Pavlo Tychyna Uman State Pedagogical University on the basis of the Faculty of Social and Psychological Education with the assistance of the Department of Family and Youth Uman City Council has established Youth Center "Start".

The purpose of the Youth Center "Start" is to create conditions for the comprehensive development and self-realization of young people in various spheres of public life, the disclosure of its potential, protection of interests and rights; promotion of social formation and development, professional orientation and organization of meaningful leisure, support of talented youth. The participants of the Center are teachers and students of the university, students of Uman and Uman district.

4 Results

Among the main results of the Youth Center "Start": the implementation of basic and applied research, implementation of their results in practice and the educational process.

Youth Center "Start" - the organizer of a number of events, including: a set of trainings on the creation of Startup-projects; a program of master classes from successful

youth leaders; information and practical course "School of Ladies and Gentlemen"; cognitive-motivational course "School of Youth Initiatives" for students of schools in Uman, non-formal education program for student youth "Youth. Education. Politics" and others. At the initiative of the participants of the Center on the basis of Pavlo Tychyna Uman State Pedagogical University on December 17–19, 2018 the Basic training of the National training program "Youth Worker" was held. Participant of various projects and competitions, in particular: prepared the project "Ensuring accessibility of facilities for applicants with disabilities" for the competitive selection of investment programs and regional development projects that can be implemented at the expense of the State Fund for Regional Development in 2021; project "Center for Employment and Professional Development for Youth of Uman" in the competition of business plans "Bank of Youth Initiatives" among the youth of Uman and won the nomination "Uman - a city of sustainable development" (the project is implemented in 2021); project "Center for Employment and Professional Development of Women with Special Needs" to the competition of initiatives aimed at promoting women's participation in local economic development among AUC members (2020), coordinator and moderator of the second stage of the program of personal and professional development of youth "Derzhavotvorets" Uman. (2020), member of the initiative group for preparation of applications for participation in the national competition "Youth Capital of Ukraine" in Uman (2021).

Within the framework of the Center's activity, cooperation and exchange of experience with youth centers from other regions and cities of Ukraine, as well as establishing international cooperation with leading European countries in the field of youth work, such as Finland, Lithuania, Poland. Members of the Youth Center are regular participants in scientific, educational and practical forums of various levels.

In 2021, the program of personal and professional development of student youth "Youth. Education. Politics". The purpose of the program is to create conditions for personal and professional development of student youth in higher education institutions in accordance with the State target social program "Youth of Ukraine" for 2021–2025. Objectives of the program: to promote personal, professional and social development of student youth; to raise the level of awareness of young people about their participation in public life, in the activities of civil society (youth organizations, student government, volunteering) / to give participants an understanding of the mechanisms of such organizations; to acquaint students with disabilities with their rights, responsibilities and opportunities for the development of their own potential and self-realization in their community; to raise the level of awareness and activity of student youth in the political life of the community; to promote the development of leadership skills of program participants; to promote the values of integrity and transparency in student youth.

The format of the program in the context of the COVID-19 epidemic in 2021 is a 5-day online training course for student youth in higher education institutions. The main components of the program: educational: trainings, seminars, practical work; informational: study visits and discussions with heads of organizations, leaders of student and city self-government, etc. formational: reflections, team building, mentoring. The main requirements for program participants: fluency in the Ukrainian language; the status of a graduate of Pavlo Tychyna Uman State Pedagogical University; desire and willingness to work in a team; interest in the youth sphere.

5 Conclusions

The program consists of 4 modules on the topics: Leadership. Formation of leadership skills; Emotional intelligence; Goal setting; Team. Motivation and group dynamics of the team; Game team exercises and tasks; Rights, responsibilities and opportunities for the development of young people with disabilities; Youth policy at the state, regional and local levels; Participation of young people in the activities of civil society institutions; Integrity and transparency in higher education; Project management; Writing projects. Their implementation within the institution of higher education.

Graduates of the program "Youth, Education, Politics" in 2021 will be issued certificates as confirmation of non-formal education.

Youth work is aimed at providing opportunities for the development of young people, their independence and autonomy; for the organization of healthy and safe leisure and rest of youth; empowering young people to change situations that they believe should be changed in their immediate environment and in society; helping young people to interact with the authorities and politicians to create opportunities for young people to be involved in non-formal education, which contributes to the development of their competence [9].

That is why youth work is seen as an effective means of non-formal civic education - teaching young people how to live in a modern state, how to abide by its laws, but at the same time not to allow the government to violate their rights, to demand their legitimate needs. society.

The development of concepts and approaches in civic education is due to the first major civic education projects co-financed by international donors, such as: Democratic Education, the Ukrainian-Canadian project of the University of Queens, Ontario; Ukrainian Civic Education Network - UCEN, founded by IREX; "Education for Democracy in Ukraine" in the framework of the Transatlantic Civil Society Support Program in Ukraine [1].

Modern practice shows the fragmentation of civic education in Ukraine. Among the reasons for this situation - the lack of practical tools for the implementation of civic education; undeveloped theoretical and methodological bases and recommendations for the training of specialists in the field of non-formal civic education, in particular youth work; differences between national and patriotic education and civic education; lack of a cross-sectoral approach to civic education to streamline the formal and informal processes; lack of special networks or platforms for cooperation between civic education providers in Ukraine.

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Evaluation on the Comprehensibility of China's Safety Prohibition Signs Based on Ergonomic Principles

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Abstract. This study is aimed to evaluate the comprehensibility of 40 safety prohibition signs in accordance with China's current national standards and their relevance to three ergonomic principles (familiarity, physical representation, and conceptual compatibility) of sign design, thereby discovering signs of poor comprehensibility. Twenty elderly people aged 60 and above were included in this study for the sign comprehensibility test and ergonomics principles evaluation test. The results revealed that there were 13 signs with a correct comprehensibility rate of 0, and no signs had a comprehensibility rate of greater than 67% specified in ISO 3864–3 (2006). A lot of signs with poor comprehensibility need to be redesigned, which should abide by ergonomics principles, thereby improving people's comprehension. This study can provide a sound theoretical basis for researchers and designers when improving these signs to design comprehensible signs for safety enhancement.

Keywords: Safety signs · Prohibition signs · Ergonomics principles · Comprehensibility

1 Introduction

Safety signs are called the last line of defense to prevent safety accidents, and their failure will directly lead to safety accidents to a certain extent. For the effectiveness of signs, a clear standard is that people have a high rate of understanding of safety signs is an essential factor in determining the effectiveness of safety signs [1]. Previous studies have found that ergonomic principles can assist the understanding of road warning signs [2]. The ergonomic principles of sign design were first proposed by Sanders. There are five main ergonomic principles: spatial compatibility - the physical arrangement in space, relative to the position of information and directions; conceptual compatibility - the extent to which symbols and codes conform to people's associations; physical representation - the similarity between the content of the sign and the reality it represents; familiarity - the extent to which the driver is familiar with the sign from their driving experience and standardization - the time to which the codes used for different dimensions, such as color and shape, are consistent for all signs [3]. Compared with young people, older

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 1250–1257, 2022.
https://doi.org/10.1007/978-3-030-85540-6_160

people understand specific symbols Encountered even more significant difficulties [4]. According to the study mentioned above. The aging effect has a significant impact on understanding signs. Scholars at home and abroad have studied the relationship between the comprehensibility of traffic signs and the ergonomic principles of sign design. However, few scholars use the elderly as subjects. The safety prohibition signs in the national standard GB 2894–2008 [5] are evaluated based on the principles of ergonomics. In this study, because the prohibition signs in the safety signs have almost no signs that indicate the concept of direction and spatial location, and China's national safety prohibition signs have standard specifications in the shape and color of the signs. Therefore, spatial compatibility and standardization were not selected for evaluation.

2 Method

2.1 Experiment 1: Assess the Comprehensibility of China's Safety Prohibition Signs

This study recruited twenty olderly people who were 60 years old and above as participants for this study. They are not color-blind, and they have never studied the Chinese safety prohibition signs and participated in similar experiments. Forty prohibition signs in GB 2894–2008 (Fig. 1) [5] were selected as the signs for the investigation, and three Chinese traffic signs were selected for the subjects to familiarize themselves with the experiment. The issues filled out a demographic questionnaire. Microsoft PowerPoint was used to display all signs. The sign is displayed in the center of the computer screen, and these signs did not carry text information. Only image symbols were displayed. The diameter is 7 cm, and the visual distance of the subject is about 60 cm [6]. After the issues saw the signs, they directly answered the meaning of signs. The experimenter recorded the length of reaction time required for each participant to recognize the signs, and the experimenter could not give Any tips from the subject. After the first test session is over, take a 2-min break and start the second test session.



Fig. 1. 40 prohibition signs of GB 2894–2008

2.2 Experiment 2: Sign-Based Ergonomic Principles, Evaluated 40 China's Safety Prohibition Signs

The researcher explained the meaning of each principle. After that, the subjects will see 40 safety prohibition signs with the correct sense on the computer screen in turn. They are required to use the dimensions of 1 to 10 to carry out the ergonomic principles of all signs. Subjective scoring. The evaluation criteria are familiarity (1 = very unfamiliar with the sign image, 10 = very familiar with the sign image). Physical representation (1 = the sign image is very dissimilar to the actual object, 10 = the sign image is very similar to the exact thing). Conceptual compatibility (1 = the sign image has no relation to the conveyed meaning, 10 = the sign image is very closely related to the given importance) [7, 8].

2.3 Data Analysis

Two judges independently assessed the accuracy of the responses given by the participants. Correct understanding of the actual meaning of the prohibitive symbol (over 80% understood) was given one point, getting very close to the real meaning (understood 66–80%) was given 0.75 points, and getting close to the exact meaning (understood 50–65%) was given 0.5 points. Showing the opposite answer to the actual meaning caused one point deduction, and 0 points were awarded for any other answer [9], and the average score of the two judges was used as the test subject Comprehension score.

3 Results

3.1 Understanding Level Results

According to the statistics of two researchers, the understanding level of none of the signs is considered acceptable by ISO 3864–3, 2006 [10] (the sign understanding rate is greater than 67%), and the sign understanding rate ranges from 0% to 52.5%. Table 2 shows the comprehension rate of 13 signs is 0.

Table 1. Results of Experiment 1 and Experiment 2

Prohibitive sign	Comprehension rate (%)	Familiarity	Physical representation	Conceptual compatibility
1 No smoking	52.5	6.85	7.2	7.4
2 No burning	10.0	3.9	6.45	7.0
3 No kindling	15.0	3.4	9.3	7.75
4 No extinguishing with water	0.5	2.4	6.55	6.25
5 No laying inflammable thing	2.5	3.75	8.35	6.95
6 No stocking	0	1.5	2.1	2.95

(*continued*)

Table 1. (*continued*)

Prohibitive sign	Comprehension rate (%)	Familiarity	Physical representation	Conceptual compatibility
7 No starting	0	2.7	7.8	5.75
8 No switching on	0	1.9	4.95	5.15
9 No turning	0	2.2	6.75	5.0
10 No access for fork lift trucks and other industrial vehicles	0.5	2.35	7.8	6.6
11 No riding	0	1.95	3.85	4.6
12 No nearing	2.5	3.95	7.55	7.9
13 No entering	17.5	2.7	7.2	5.45
14 No pushing	12.5	1.9	6.45	7.05
15 No stopping	2.5	2.35	7.45	6.15
16 No throughfare	15.0	5.0	8.85	7.3
17 No striding	17.5	2.4	7.7	7.55
18 No climbing	17.5	2.5	6.25	6.75
19 No jumping down	10.0	1.4	4.95	6.45
20 No stretching out of the window	0	1.45	5.05	4.8
21 No leaning	27.5	2.95	6.85	6.5
22 No sitting	30.0	4.45	6.65	7.45
23 No stepping on surface	0	2.3	7.55	6.35
24 No touching	7.5	2.45	4.35	3.95
25 No reaching in	0	2.1	4.05	4.85
26 No drinking	10.0	2.5	8.05	5.8
27 No tossing	0	1.5	5.1	5.15
28 No putting on gloves	20.0	1.5	7.7	5.25
29 No putting on chemical fibre clothings	27.5	2.35	7.2	5.35
30 No putting on spikes	0.5	1.55	3.7	4.35
31 No activated mobile phones	2.5	2.45	6.95	6.35

(*continued*)

Table 1. (*continued*)

Prohibitive sign	Comprehension rate (%)	Familiarity	Physical representation	Conceptual compatibility
32 No metallic articles or watches	0	1.9	5.8	4.7
33 No access for persons with pacemakers	0	1.45	2.85	3.1
34 No access for persons with metallic implants	0	1.1	1.55	2.05
35 No swimming	45.0	5.25	7.25	6.25
36 No skating	52.5	4.8	9.4	9.0
37 No carring weapons and emulating weapons	17.5	3.25	9.4	8.65
38 No carring flammable and explosive materials	0	2.95	6.8	5.95
39 No carring poisonous materials and harmful liquid	2.5	4.0	6.75	6.3
40 No carring radioactive and maghetic materials	0	2.0	4.4	4.8
Overall (1–40)	10.5	/	/	/

3.2 Evaluation Results of the Ergonomic Principles of the Sign

Table 1 shows the results of the evaluation of the ergonomic principles of the sign. Linear regression analysis revealed a significant correlation between the three ergonomic principles and the signed understanding rate ($p < 0.01$). The correlation coefficient between comprehension rate and familiarity is 0.699, the correlation coefficient between comprehension rate and physical representation is 0.446, and the correlation coefficient between comprehension rate and concept compatibility is 0.521. In addition, one of the three ergonomic principles of the mark is also a significant correlation between ($p < 0.001$), among which the correlation coefficient between familiarity and physical representation is 0.578, the correlation coefficient between familiarity and conceptual compatibility is 0.660. The correlation coefficient between physical expression and conceptual compatibility is the highest at 0.855.

Table 2. 13 signs with 0 comprehension rate

Prohibitive sign	Comprehension rate (%)	Familiarity	Physical representation	Conceptual compatibility
6 No stocking	0	1.5	2.1	2.95
7 No starting	0	2.7	7.8	5.75
8 No switching on	0	1.9	4.95	5.15
9 No turning	0	2.2	6.75	5.0
20 No stretching out of the window	0	1.45	5.05	4.8
23 No stepping on surface	0	2.3	7.55	6.35
25 No reaching in	0	2.1	4.05	4.85
27 No tossing	0	1.5	5.1	5.15
32 No metallic articles or watches	0	1.9	5.8	4.7
33 No access for persons with pacemakers	0	1.45	2.85	3.1
34 No access for persons with metallic implants	0	1.1	1.55	2.05
38 No carring flammable and explosive materials	0	2.95	6.8	5.95
40 No carring radioactive and maghetic materials	0	2.0	4.4	4.8

4 Discussion

The purpose is to evaluate the comprehensibility of 40 safety prohibition signs under China's current national standards and their relevance to three ergonomic principles (familiarity, physical representation, and conceptual compatibility) of sign design, thereby discovering signs of poor comprehensibility. This study found that according to the ISO 3864–3, 2006 standard, none of the 40 Chinese safety prohibition signs reached an acceptable level of understanding (at least 67%). According to the study results, the main reasons for the low level of learning are:

First, the subject's city is in a rural area. The older participants possibly preferred to restrict themselves to familiar environments and thus were unfamiliar with some of the Chinese safety prohibition signs. And some signs may be seen for the first time, so they have never been exposed to these older subjects, making it difficult to understand. Second, the actual objects used in the sign do not match the real expressions seen by the issues in their lives, so the sign cannot be understood. Third, the connection between the image in the sign and the meaning conveyed by the sign is shallow. As a result, it is difficult for people to think of the actual meaning of the sign, making the sign challenging to understand. Sign designers should ensure that the signs they design comply with the ergonomic principles of the sign and can be correctly understood when they see the sign for the first time. It is of great necessity to improve the sign's understanding rate to choose familiar things and situations. Such items and conditions can make people associate the sign accurately.

5 Conclusion

Among the 40 China's safety prohibition signs, There are 13 signs with a 0 comprehension rate, and the understanding rate of no signs is greater than the 67% understanding rate specified in ISO 3864–3 (2006). It shows that many signs with poor comprehensibility need to be redesigned, and the redesigned signs should better follow the principles of sexual ergonomics to improve people's understanding. This study provides designers with a proper theoretical basis when redesigning these signs in the future to produce easy-to-understand signs that enhance safety.

Acknowledgments. Thanks to the teachers and students who helped complete this study and the subjects who participated in the experiment.

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Downstream Applications: How is Safety Targeted?

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Abstract. Based on a systematic literature review, this study aims to survey applications regarding how the concept of "downstream" is used. Taking as a starting point the research question: "Based on scientific literature, in which areas is downstream used?", it will leave us to obtain a more accurate image of the areas which make use of "downstream" and in what context. Considering the documents found, a descriptive analysis was attained, allowing a 'big picture', and then a set of documents were selected for critical analysis. To complement the analysis, bibliometric maps where developed for the co-authorship and co-citation networks, allowing the identification of clusters for authors' countries considering documents' weights and density by item and keywords. Based on the score of the keywords by average of occurrence by publication year, it is possible to visualize their use over the years. The results show a current trend in the use of "satellite data" and "imagery" and "downstream applications".

Keywords: Aerospace · Downstream · Safety · Satellite

1 Introduction

Generally speaking, "downstream" corresponds to the direction in which a stream or river flows. However, this word together with "upstream", are both used extensively independently of the area of knowledge. Nowadays, with the higher number of satellites, it is important to discuss the importance of the downstream applications and opportunities that space derived data have and in which areas. So, this study aims to survey all applications regarding "downstream", that is, how the concept of downstream is used.

Taking as a starting point the research question:

"Based on scientific literature, in which areas is downstream used?"

it will leave us to gain a more accurate image of what are the areas that make use of "downstream" and in what context.

This paper is divided into four sections. Following the first section, regarding the introduction, Sect. 2 presents the research method expended. In Sect. 3 the results and discussion are presented based on the research strategy describing the actual trend on

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 1258–1266, 2022.
https://doi.org/10.1007/978-3-030-85540-6_161

the scientific research areas of application and the identification of relevant studies that should be considered. Although, the process of analysis is still work in progress, Sect. 4, final section, presents the conclusions and suggestions for future research.

2 Methods

In this section the methods followed are described: a Systematic Literature Review (SLR) and the Statistical analysis used.

2.1 Systematic Literature Review

To answer the research question which has been raised, a SLR was conducted based in all published studies related to downstream and their application areas [1, 2]. The Scopus was the database used.

The combination of keywords: ((satellite OR aerospace) AND downstream*), were used in the Keywords field, where the use of the asterisk allow the search term to lead a longer word. No restriction to the time frame was considered allowing to verify the evolution of this topic over time and whenever a change is made. The search includes articles, proceedings papers, review and book chapters. The search, conducted on 19 April 2021, yielded 150 articles. Table 1 shows the number of documents founded based on different keywords combinations.

Considering all articles, a descriptive analysis was attained allowing a ´big picture´ and then a set of documents were selected for critical analysis. The exclusion criteria applied considered documents that used the concept of "downstream" in business where the word, together with upstream, are parts of the supply chain, and similar consideration regarding oil and gas industry. So, as inclusion criteria the studies that highlighted the relationship between the use of downstream and the use of satellite to obtained terrestrial date. Studies that are not full available and with low or very low relevance regarding the main objective under analysis were not considered. In most of the cases, the document was reject based on the title and/or abstract. In others cases, where can be doubts, the documents were selected for a more detail reading. This process were performed by the two researchers and co-authors of the present study where all the information was collected and recorded in the PRISMA flowchart [3].

Table 1. Database search results by keywords combination considered by filter type considered.

No	Filter type	Keywords combination	Number
#1	Keywords	(downstream* AND application*)	1,154
#2	Abstract		19,759
#3	Article title, abstract and keywords		27,087
#4	All fields		200,339
#5	Keywords	((satellite OR aerospace) AND downstream*)	150

2.2 Descriptive Statistical Analysis

The database search results are shown in Table 1, giving the base topics previously identified. The values in parentheses relate to the values obtained after the application of the inclusion/exclusion criteria. The data that will be analyzed in this study correspond to 150 documents found in search #5. The publication years range from 1975, with one publication, and 2022, up to now (19th April 2021) already with five publications (Fig. 1). Despite some swings, the number of publications over the years there is a upward trend, being 2012 the year with the greater value with 16 documents published. Conversely, the year of 2006 with no publication.

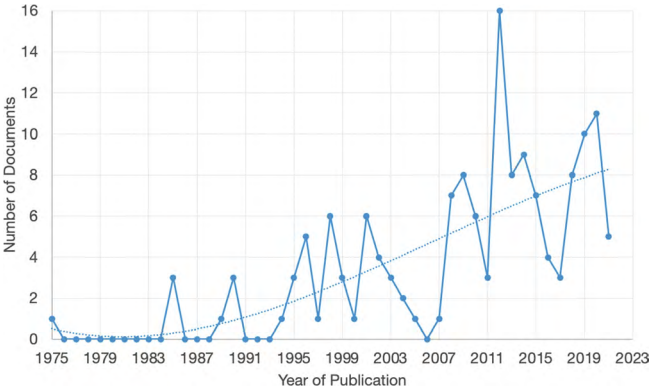


Fig. 1. Documents by year of publication and upward tendency.

36 countries were identified with at least one document. In Fig. 2(a) the list the countries with three or more publications. United Sates (USA) has the greatest number of publications (73), accounting for 49.3% of all the 150 documents found in search #5. At the second position, with a great difference, United Kingdom (UK) with 15, China with 14, Germany with 13, and Japan with 11. These four countries ac-counting for 35.3% of all the documents. The majority of the documents are conference papers (62.0%) and articles (36.0%), Fig. 2(b). Regarding the subject areas of the publication of these studies, the most significant is in engineering area (36.4%), followed by earth and planetary sciences with 26.8%, and environmental science area with 7.4% (Fig. 2(c)).

For constructing and viewing bibliometric maps, the free software VOSviewer was used [4, 5]. It was chosen for its friendly graphical user interface and maps of the co-authorship and co-citation networks.

Based on the 36 countries identified with at least one document, and regarding co-authorship, with a minimum of 3 documents of a country, that is only 13 countries were considered (36.1%), and one country (Poland) since it is not connected to other countries, it was not considered in the analysis. The network visualization considering documents' weights and citations (Fig. 3(a) and (b), respectively), USA with the highest value. But, when considered the total link strength as the measure of weights, UK have gradually increase until match USA (Fig. 3(c)). The top 12 countries with their documents frequencies and total link strengths are shown in Table 2.

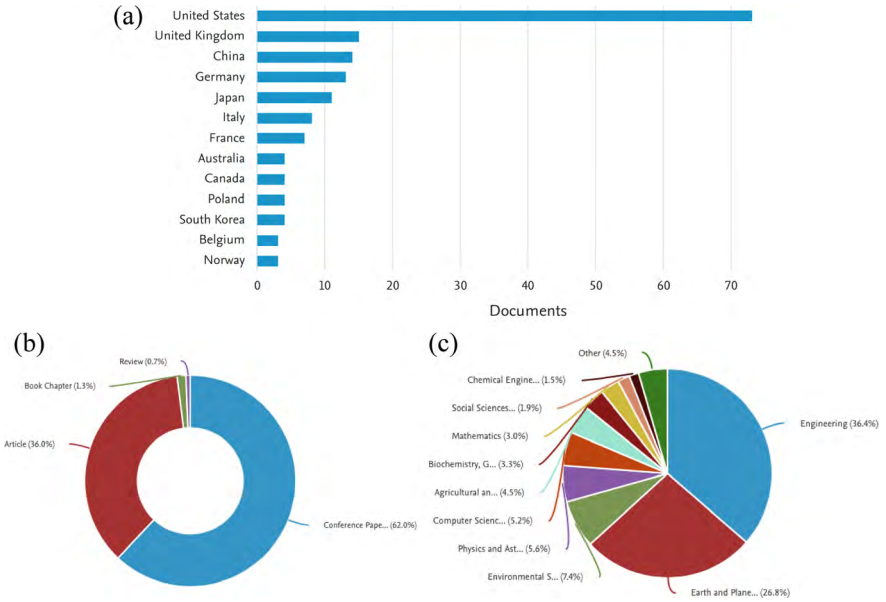


Fig. 2. Documents by: (a) country/territory, (b) type, and (c) subject area.

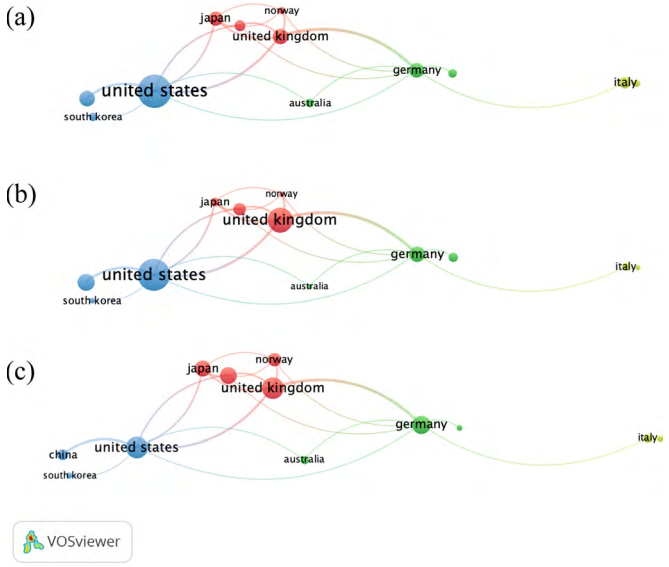


Fig. 3. Network visualization of co-authorship by countries, considering: (a) documents' weights, (b) citations, and (c) total link strength.

Table 2. Top 12 countries documents' frequencies ordered by their total link strengths.

Country	Documents	Citations	Total link strength
UK	15	447	13
USA	73	751	13
Germany	13	165	10
France	7	104	8
Japan	11	50	7
Norway	3	13	5
China	15	199	3
Australia	4	6	2
Italy	8	38	2
Belgium	3	3	1
Canada	4	63	1
South Korea	4	22	1

It is interesting to observe that the citations scored by weights over the years shows that European countries like Norway, France and Germany, recently, start publishing information related this topic (Fig. 4).

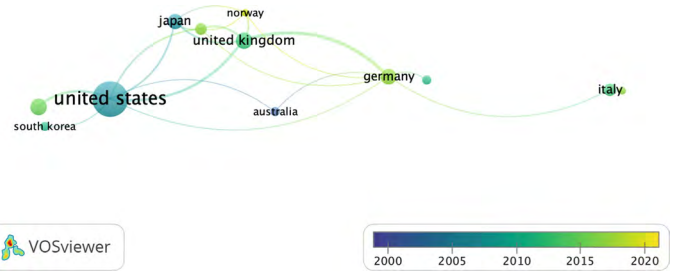


Fig. 4. Overlay visualization for authors' countries over the years considering documents' citations.

Figure 5 illustrate the network obtained for the keyword co-occurrence map based on bibliographic data. The distance between two keywords in the visualization approximately indicates the relatedness of the them in terms of co-occurrence links, meaning that, the closer two keywords are located to each other, the stronger their relatedness. The line thickness represent the co-occurrence strongness link between two keywords. For example "satellite data" lies at practically of equal distance between "satellite imagery" and "downstream applications".

Identical interpretation and analysis could be done as previously, now based on the density visualization regarding the association strength. From the cluster density visualization, the three clusters are easily identifiable by the three colors: green for "aerospace engineering", red for "downstream region" and "satellite imagery", and blue for other areas like "computational fluid dynamics".

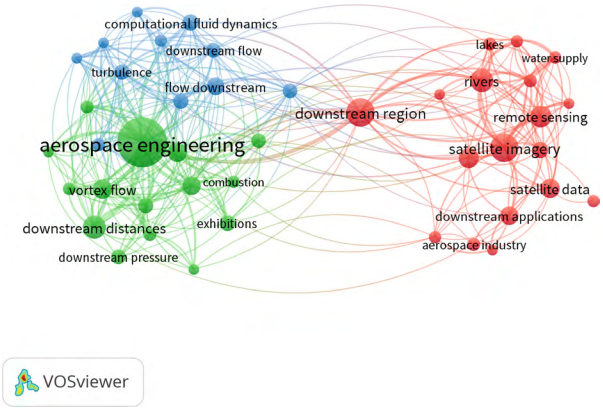


Fig. 5. Network visualization based on keywords.

Another interesting point of the analysis made is regarding the score of the keywords by average occurrence by publication year, as Fig. 6 illustrates. The color, that indicate publication year of documents, correspondence is shown in the color bar in the bottom right corner. For example, keywords colored green have emerged in the early 2000s, and keywords colored yellow more recently. So, reading the figure from left to right, we can have a perception on the evolution of the use of words regarding downstream: at the beginning of the 2000's still linked to flow and turbulence, then around 2010, water flow, and recently with the use of "satellite imagery" and "satellite data".

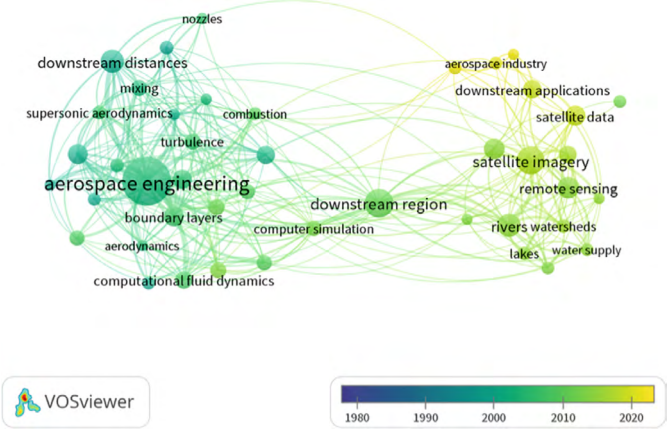


Fig. 6. Overlay visualization of keywords over the years.

These last results show the actual trend by using satellite data and imagery and downstream applications. This will help to refine and select the data results in order to answer the main research question of this study.

3 Findings and Discussion

This section presents the discussion of the results obtained based on the identified relevant studies in order to get an answer to the research question formulated. Taking into account the previous aspects identified and explained in previous section, is possible to identify the relevant studies. Table 3 summarizes the studies (journal articles) that were included which will provide opportunity to answer the research question of this study.

Table 3. Studies included.

Article no	Author(s) and publication year	Title	Keywords
[6]	Vernile (2021)	Space for society: how Eurisy's activities and research support public awareness raising on satellite applications in meeting societal needs	Applications · downstream · end users · service providers · space policy
[7]	Lipponen et al. (2020)	Advanced ultraviolet radiation and ozone retrieval for applications—surface ultraviolet radiation products	ultraviolet radiation · UV index · radiative transfer modeling
[8]	Annys, Ghebreyohannes and Nyssen (2018)	Impact of hydropower dam operation and management on downstream hydrogeomorphology in semi-arid environments (Tekeze, Northern Ethiopia)	river regulation · hydropower generation · downstream hydrology · downstream river morphology · reservoir operation and management
[9]	Rounce, Watson and McKinnet (2017)	Identification of hazard and risk for glacial lakes in the Nepal Himalaya using satellite imagery from 2000–2015	glacial lake · Nepal · risk · hazard · downstream impact · avalanche · rockfall · moraine stability · lake expansion

In Vernile [6] work describes the shift that occurs in the 21st century regarding space innovation that become more closer to the society showing also their continuous

evolution. The author highlight the importance of the society awareness of the benefits from connecting space and society. Satellite-based technologies, like Satellite Imagery, Navigation and Telecommunications, can be used not only for single application but also covering multiple fields. Environment, climate and health were identified with high potential mainly on environmental issues (i.e. air quality monitoring, environmental sustainability), on climate change applied to the vegetation preservation and health sector knowing that healthcare should be accessible by everyone through every means.

In Lipponen et al. [7] work, a more technical work in which the authors expound a satellite-based UV algorithm, AURORA, where UV index (UVI) and UV-A are delivered from synthetic satellite measurements. The UV algorithm developed is flexible being adapted to the input from any satellite measurements offering valuable global UV information to the health applications.

In Annys et al. (2018) [8] and Rounce, Watson and McKinnet (2017) [9] works, both describe applications of the multi-year high-resolution satellite imagery, along with other types of data, in the analysis of dam operation and glacial lakes in management and decision with the main objective of reducing future risks, hazard and downstream impacts in safeguard downstream users and ecosystems.

4 Conclusions

This study is the first step to explore the tendency in the use of space innovation, through the research question: "Based on scientific literature, in which areas is downstream used?". There is an actual in using satellite data and imagery getting closer to the society with several applications from Environment, climate and health among others.

Future investigations should address the extent to which and how the satellite information and downstream applications can be used, considering safety as a pillar.

Acknowledgments. The authors would like to express their thanks to FCT – Fundação para a Ciência e Tecnologia, for all the support provided in the scope of the R&D Unit Project Scope: UIDB/00319/2020.

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Observatory for the Integration of Engineering in the Economic Development Ecosystem of the Baja California Peninsula

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Abstract. Project in the process of scientific research to identify the typology of productive chains and business vocations of the ecosystems of economic development in the populations of the Baja California Peninsula and with it the relevance and integration of the engineering careers of the Tecnológico Nacional de Mexico Campus Tijuana [1] in the region. With the purpose of strengthening sectoral ties, social and regional development. The research will be carried out in the cities of Tijuana, Ensenada and Mexicali through the methodological proposal for the construction of variables of an Observatory for sectoral systemic analysis. The research focuses on two areas of interest; the relevance of the study program of the TecNM [2] engineering careers in the region. First, identify the professional competencies of the Engineers who intervene in the supply chain within companies and manage local supply as a competitive strategy in the regional economic development ecosystem. The second approach is the factors that intervene in entrepreneurship such as MSMEs in the strategic service [3] sector as a key strategy for promoting local supply as professional development of engineers graduated from TecNM in the Baja California Peninsula. The results of the research will define the bases to develop an Observatory for the integration of engineering in the ecosystem of economic development of the Baja California Peninsula, generating inputs from the research indicators called Dictionaries of Professional Competences [4] of the careers of engineering, as well as the conditions to develop a sector linkage and continuing education program that aligns with the needs of the institutional development plan and the state development plan that links the Tijuana Technological Institute, offering professional updating activities with internship activities of social service, professional residencies and postgraduate research projects for theses [5].

Keywords: Development observatory · Economic ecosystem · Sector development

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 1267–1271, 2022.
https://doi.org/10.1007/978-3-030-85540-6_162

1 Introduction

The variables considered for the research will be the product of the methodology developed with a systemic approach, in order to consider the business relationship and the experience of specialists in the industrial and logistics services sector and the different specialties, considering the development of instruments validated by experts in local supply, as well as, in-depth interviews, surveys and the treatment of qualitative and quantitative information resulting from scientific research. Table 1 shows the approach to the systematic structure of the research, the methodology to be used and its focus variables, for the development of QHS-type [6, 7] interviews and focus groups.

Table 1. Methodological systematic structure

Methodology	Variables of the research
Elements of the Fifth Helice Systemic Methodology (in spanish known as *QHS – Quinta Helice Sistemica*)	1. Government sector 2. Education sector 3. Business sector 4. Business chambers sector, trade unions 5. Consulting sector

The research contemplates a general objective focused on the analysis of the integration of students graduated from engineering careers with the purpose of identifying traceability and monitoring from basic education, preparatory and professional studies, as a strategy to identify the preference of employability and selection of professional career, likewise the location of their labor integration or even being an entrepreneur. The research contemplates the scope of the following three specific objectives.

1. Identify the types of engineering occupational profiles and their level of integration in the economic development ecosystem of the Baja California Peninsula that impact the development of local and regional supply.
2. Design the professional competencies for the TecNM engineers in the Baja California Peninsula region according to the complexity levels of the economic sectors and regional vocations (Dictionaries of Labor, Professional and Research Competencies).
3. Systematize the research variables for the design and development of a web page that generates statistics to provide data mining to society through an Observatory for the Integration of Engineering in the Economic Development Ecosystem of the Baja California Peninsula, to aligned with global requirements and National, State and Local Development Plans.

For the research project of the development of the Observatory, in the demonstration phase the development of the database will be carried out with the graduates and students of the logistics engineering career of the city of Tijuana, Mexicali and Ensenada.

2 Framework

According to the recommendations of the report of the Organization for Economic Cooperation and Development [8], on competences in Mexico [9], the current model of the Mexican competencies system has the opportunity to rethink actions aimed at strengthening the official model with proposals and initiatives from each strategic sector. For this reason, in the city of Tijuana through applied research from the academy and with information from the Secretary of Economic Development of Tijuana [10, 11] the research focuses on the challenges indicated by the OECD to strengthen competitiveness, development and social progress. Based on the impact that higher technological education represents, engineering for the development of the economic development ecosystem of the sector. This makes it necessary to reflect on current progress and results in the use of labor, professional and research competencies standards [12].

1. Design and application of questionnaires with a systematic approach to identify the gap between the graduation profile and the professional competencies required and developed
2. Design and development of in-depth interviews to identify the gap between the graduate profile and the required professional skills.
3. Preparation of the Dictionary of Professional Competences according to the typology of engineering identified in the sectors of the economic development ecosystem of the Baja California Peninsula
4. Validation of the professional competences of the Logistics Engineer with the entrepreneurs of the Strategic Logistics Services Sector.
5. Definition of the five levels for each professional competence considered in the Dictionary of Competences.
6. Development of the Continuing Education Program and Proposal for the design of Professional Skills Standards by levels, for evaluation and certification processes.
7. Preparation and presentation of the Technical Reports of the investigation and Final.

For the development of the tools for the analysis of logistics engineering competencies, a documentary and referential research was carried out at an international level through the shared case of Mexico [13], Colombia [14], Chile [15], Australia [16], such as the comparison between universities that offer the engineering career in logistics [17, 18].

3 Conclusions

The instrumentalization of the systemic methodology in the investigation will allow the sectoral linkage, allowing the effectiveness of the interaction and research processes of the University-Company type. The Technological Institutes of Tijuana, Ensenada and Mexicali have a Technological Management and Liaison Department, which is coordinated with the Liaison Project Headquarters and Research Project Headquarters. As well as the Postgraduate Coordination in each academic Department.

The linking actions of the research project will involve the collaboration efforts of organizations such as Government Institutions, Companies, Education, Associations, Clusters and specialized Consultants.

The educational programs of Engineering of the three Technological Institute in the cities of Tijuana, Ensenada and Mexicali have collaboration agreements and bases of agreement with the main chambers and business associations, with the clusters of the strategic sectors relevant to the educational programs offered; with public and private universities where, common educational programs are taught. These Bases of Agreement with companies from different sectors formalize the projects of Professional Residencies of students and future professionals. The project of the Observatory for the Integration of Engineering into the Ecosystem of Economic Development of the Baja California Peninsula, will strengthen the link and relevance of the study programs of the Engineering career, as well as the indicators, goals and projects of the Annual Institutional Program (PIA), reflected in the indicators of the strategic objectives of the Institutional Strategic Program of each Technological Institute.

The challenges that are reflected in the Report of the Global Ecomomic Forum [19], for the case of Mexico [20], and its educational levels for educational competitiveness, generates a gap to strengthen labor, professional and research skills to strengthen the competitiveness of the educational sector according to to the relevance and aligned to the strategic sectors of the State of Baja California, that is why the project of the Observatory of the integration of engineers to the ecosystem of economic development of the Baja California peninsula as a strategy to systematize the sectorial needs by means of identifying traceability of employability and educational preference, identifying the evolution of educational careers in the region versus the demand for employability in business and organizational sectors.

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Observatory for the Development of 2030 Goals and the Circular Economy in Baja California

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Abstract. The development of this scientific research project with a descriptive scope with documentary analysis to support the theoretical framework to determine if there is a relationship between the variables that have an impact on the degree of visibility and evolution of the Sustainable Development Goals (SDG) of the UN 2030 [1]. Goals and the implementation of the Circular Economy in SMEs in Baja California, as well as the Social Economy and Social Innovation undertakings and practices. Through the systemic methodological application as a reference index and sector feedback, from the Tecnologico Nacional de Mexico Campus Tijuana [2] to society through a Web Page. That it can provide information on the detection and evaluation of the evolution of the SDGs to identify opportunities, programs and actions to develop; evaluate the critical factors that promote social innovation and sectoral articulation for the benefit of society and the different levels of education; strengthening the skills of future generations.

The results will provide necessary information that may be useful for awareness-raising and technical assistance actions at the local level for the development of capacities of SMEs and competence laboratories in Technological Higher Education, Higher Secondary Education and Basic Education. Likewise, to society in general by means of linking and social service through the linking of different sectors such as the Government, Academia, Companies, Associations and sectoral specialists.

Keywords: SDGs observatory · Economic ecosystem · Sector development

1 Introduction

The development of a Social Economy Observatory aims to carry out analysis of the indicators that generate the traceability of the behavior of the development of the 2030 goals and the evolution of the actions aimed at the circular economy in Baja California, and is derived from the research project the integration of graduates of engineering

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 1272–1277, 2022.
https://doi.org/10.1007/978-3-030-85540-6_163

careers into the social economy, a project registered with the National Technological Institute of Mexico, being an initiative of the Tijuana Campus (Technological Institute of Tijuana) through the project of the Academic Body in formation called: "Competitiveness and innovation for sustainable regional development", attached to the Department of Economic-Administrative Sciences and the Division of Postgraduate Studies and Research, being the Master's Degree Program in Administration, the Doctorate in Administration and the CIIDETEC [3]. Innovation and Research Center the base of its member researchers. As well as alliances with other Academic Bodies of the Autonomous University of Baja California, Technological University of Tijuana, University of Guadalajara and the Tijuana City Council, through the Secretary of Economic Development, through the Commission for the Promotion of the Social Economy of Tijuana [4] and CIRIEC Mexico North Region with national and international ties. The actions developed in a systematic way and sector linkage will contribute to the strengthening of public policies and the development of a NODESS (Development nodes of social economy) project for the city of Tijuana and its metropolitan area. In the Table 1 shows the approach to the systematic structure of the Observatory design, based on the QHS methodology, with its focus variables for the Sustainable Development Goals (SDGs) three follow-up phases for the development of information collection and systematization instruments and their respective data mining for sectoral foresight [5].

Table 1. SDGs follow-up implementation phases

	Phase 1	Phase 2	Phase 3
1. End of poverty	No	No	Yes
2. Zero hunger	No	No	Yes
3. Health & Wellness	Yes	Yes	Yes
4. Quality education	Yes	Yes	Yes
5. Gender equality	No	Yes	Yes
6. Clean water and sanitation	No	No	Yes
7. Affordable and clean energy	Yes	Yes	Yes
8. Decent work and economic growth	Yes	Yes	Yes
9. Industry, innovation and infrastructure	Yes	Yes	Yes
10. Reduction of inequalities	Yes	Yes	Yes
11. Sustainable community cities	Yes	Yes	Yes
12. Responsible consumption and production	No	Yes	Yes
13. Climate action	No	No	Yes
14. Submarine life	No	Yes	Yes
15. Terrestrial ecosystem life	No	No	Yes
16. Peace, justice and strong institutions	Yes	Yes	Yes
17. Partnerships to achieve the objectives	Yes	Yes	Yes

The effective integration of engineering to the challenges of society and development of responses to the needs of society, such as the contingency of the COVID-19 pandemic [6]; for which it is proposed, from the coordinated work between institutions of Middle and Higher Education, business organizations, Government and representatives of Civil Society, the development of a social economy project, to meet the need to provide a COVID-19 Health Kit and Educational APP in response to the need for health awareness, through regional capacities and linkages, promoting productive entrepreneurship in the Social Economy with the support of the education sector. It will provide a response to the global emergency of the COVID-19 pandemic, it is the attention to the needs of the citizenship that requires support for antibacterial protection and an effective awareness of preventive care to avoid contagion in daily activities and in public spaces. For this reason, through the actions of an observatory that coordinates the integration of all sectors of society, it represents an opportunity to make a common front, for the benefit of the community, by linking regional capacities. The single stage of the project includes the definition of the priorities of respiratory protection equipment, masks and antibacterial gel, the above as a basis to develop through social economy activities according to the WHO and the Government of Mexico.

2 Framework

The research project supports the systemic integration methodology through the QHS methodology [7] that articulates the Academy, Industry and Government, as well as the challenges of professional competences established by the OECD [7] for the strengthening of development capacities. This proposal integrates a multidisciplinary interinstitutional work team with technical infrastructure and administrative capacities of the participants in the project to develop an OBSERVATORY that monitors regional sector needs, chain capacities, profile required for the effective integration of engineering to the challenges of society and development of responses to the needs of society, such as the contingency of the COVID-19 pandemic; For which it is proposed, from the coordinated work between institutions of Middle and Higher Education, business organizations, Government and representatives of Civil Society, the development of a social economy project, to meet the need to provide a SANITARY KIT COVID-19 and EDUCATIONAL APP in attention to the need for health awareness, through regional capacities and chains, promoting entrepreneurship production of the Social Economy with the support of the educational sector.

Specific demand to be addressed: Validation and/or national production of medical materials, devices and/or equipment strategic materials with endemic or easily accessible materials in the country and low cost. The research project proposal is aimed at the development and production of COVID-19 SANITARY KIT and EDUCATIONAL APP that serve as immediate support for the containment of the pandemic. The Kit will serve to support families, schools and society in general during the health contingency, in public spaces for community protection. According to the World Health Organization [8] coronaviruses are an extensive family of viruses that can cause disease in both animals and humans. In humans, various coronaviruses are known to cause respiratory infections that can range from the common cold to more serious illnesses such as Middle East

respiratory syndrome (MERS) and severe acute respiratory syndrome (SARS). The most recently discovered coronavirus causes the coronavirus disease COVID-19. Both the new virus and the disease were unknown before the outbreak broke out in Wuhan, China in December 2019. This event has generated an alert and priority for citizens around the world. For Mexico and in each region of the population of the national territory, it is necessary that efforts of intellectual and sectoral disciplines replicate support efforts for the organization of social economy activities for the development, production and distribution of KITS. In Mexico and especially the Northwest Zone, focusing on the border region of the cities of Tijuana, Tecate and Mexicali, which are adjacent to the cities of San Diego, Tecate and Calexico, California in the United States of America. The capacity of respiratory protection equipment, antibacterial gel, masks and above all the massive and precise awareness of how to mitigate the effects of infections due to lack of care and prevention have been affected and exceeded. The observatory addresses the challenge of the implications of the response needs to the global COVID-19 contingency and its form and initiatives to generate actions to mitigate the effects on society and return to the new normal.

The foregoing aimed at meeting the challenges of the objective of Sustainable Development Goal 3: Health and Well-being (2030 Goals), which aims to guarantee a healthy life and well-being for all people of all ages. That is why the objective of this research from the Observatory is the development of a proposal for a support KIT in the face of the health contingency and after the new COVID-19 normality. Table 2 shows the specific objectives and goals of the objective house to be developed in the face of the global contingency that has affected public health and safety in all sectors of society.

Table 2. Project to SDGs 3: health and well-being.

Specific objectives	Objective goals	Short description
1. Promote scientific collaboration through thematic research networks	Research journal	Sectorial articulation and integration of engineering to the sectors economic and strategic aspects of society
2. Promote the inclusion of specialized human resources in strategic sectors	School sanitary kit COVID-19	It will contain: mask, antibacterial gel
3. Academic training in science, technology and innovation in social needs	Observatory website	Sectorial articulation through information technologies and social networks

A response to the global emergency of the COVID-19 pandemic, is the attention to the needs of the citizenry that requires support for antibacterial protection and an effective awareness of preventive care to avoid contagion in daily activities and in public spaces. For this reason, through the actions of an observatory that coordinates the integration of all sectors of society, it represents an opportunity to make a common front,

for the benefit of the community, by linking regional capacities. The single stage of the project includes the definition of the priorities of respiratory protection equipment, masks and antibacterial gel, the above as a basis for developing the development of face masks through social and community economy activities and with the collaboration of Secondary Education institutions. And Superior the development of equipment for masks and antibacterial gel in high volume, to attend the contingency in public spaces, in homes and community centers. GOAL DESCRIPTION Development of a sectoral integration program that generates social economy with the production of COVID-19 SANITARY KIT and EDUCATIONAL APP, to provide citizens and in public spaces actions that mitigate and improve public health, as well as common welfare [9].

For the purposes of the Observatory project with a Circular Economy approach, it consists of a production model based on sharing, renting, reusing, repairing, renewing and recycling existing materials and products to create added value and with this the life cycle of the products is extend. Therefore, the variables to be considered will be in the phases of raw materials, design, production, reprocessing, distribution, consumption, use, reuse, repair, collection, recycling (residual waste) [10].

3 Conclusions

That is why, through the development of the "Observatory for the Development of 2030 Goals and the Circular Economy in Baja California" for coordination and integration of the sectors of Middle and Higher Education, Companies, Business Organizations and Municipal Government, has been created a Commission for the Promotion of the Social Economy, to identify actions and proposals that are necessary for the common good from the needs that impact on the various sectors of society.

The development of the research project involves the coordination and integration of the sectors of Middle and Higher Education, Companies, Business Organizations and Municipal Government, a Commission for the Promotion of the Social Economy has been created, to identify actions and proposals necessary for the common good from the needs that impact on the various sectors of society. In Mexico and especially the Northwest Zone, focusing on the border region of the cities of Tijuana, Tecate and Mexicali, which are adjacent to the cities of San Diego, Tecate and El Calexico, California in the United States of America. Due to the fact that the capacity of respiratory protection equipment, antibacterial gel, masks have been affected and exceeded, but especially in the massive and precise awareness of how to mitigate the effects of infections due to lack of care and prevention [11].

The benefits and results of this research will have a direct impact on public health and educational actions that will mitigate the risks of contagion in the face of the pandemic, generating the analysis of the relevance of study programs, social responsibility and integration to sector needs. As an additional benefit, the profiles of professional skills demanded by the productive sector will be validated, as well as in the supply chain, local suppliers, through the generation of scientific and technological knowledge [10].

The SARS-Cov-2 coronavirus is a virus that appeared in China. Then it spread to all the continents of the world causing a pandemic. Currently Europe and America are the most affected. This new virus causes the disease known as COVID-19. People with

COVID-19 have the following signs and symptoms: a) Cough and / or fever and / or headache, b) And it is accompanied by at least one of the following: sore or burning throat, red eyes, pain in muscles or joints (general malaise). c) The most severe cases have breathing difficulties or shortness of breath in their lungs [12].

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Observatory of Labor, Professional and Research Competencies of the Economic Sectors in Baja California

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Abstract. This applied research initiative is aimed at developing actions to strengthen sectoral competitiveness, the experience generated in the productive vocations of each region of Mexico [1], the frame of reference of investigations developed in the Technological Institutes at the national level. The objective is to develop the model for the design and development of the Dictionary of Sector Competencies (DCS) [2]. The application of a sectoral integration methodology will facilitate the identification of needs from a comprehensive approach and of relevance according to the competencies required in each productive sector, whether public or private.; DCS arises from the sector of technological higher education, considering the relevance of the Tecnologico Nacional de Mexico [3] Campus Tijuana [4] towards innovation. According to the 2017 report of the Organization for Economic Cooperation and Development (OECD) [5] on skills in Mexico. The research in this article proposes the design of competency standards according to the different levels established by ISCED-UNESCO, in the specific case the competences of level 6, 7 and 8 [6], as well as the national model and the effective methodology to move to the next stage of development of the sectors, The goal is to design and propose methodological alternatives to develop competency standards that cover business requirements for job performance and aspects of professional development, considering management skills strengthened with applied research, based on the study plans of the Tecnologico Nacional de Mexico. Tijuana campus.

Keywords: Job competence · Professional competence · Research competition

1 Introduction

This applied research initiative is aimed at the development of the Observatory of labor, professional and research competencies of the economic sectors in Baja California for the strengthening of sectoral competitiveness, The research promoted by the Technological Research and Innovation Center (CIIDETEC) is a national initiative of the Division of Graduate Studies and Research as a contribution to the challenges of competitiveness

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 1278–1282, 2022.
https://doi.org/10.1007/978-3-030-85540-6_164

in higher technological education in Mexico. The objective is to develop the model for the design and development of the Dictionary of Sector Competencies (DCS) [7, 8]. The DCS arises from the technological higher education sector, considering the relevance of the National Technological Institute of Mexico towards educational innovation and alignment of the needs of extra-strategic sectors to identify the traceability of employability and preference of companies by type of skills requested for your engineer vacancies.

The OECD [9] The challenges of governments and institutions have to focus cooperation efforts between each of the sectors that represent society in such a way that through linkage mechanisms and consultation forums, public policies are aligned according to the needs of companies and from the training of the talent of the new generations in the educational sector the relevant skills, both technical skills and soft skills in an increasingly global and multicultural economy. In this context, Table 1 presents the relevant competencies for development and sector strengthening.

Table 1. OECD report for skills

OECD report	Variables of the research
Relevant competencies for the development and sector strengthening	1) Improve the level of competencies of compulsory education students 2) Increase the options for new generations to enter higher education 3) Generation of efficient linkage mechanisms for professional updating 4) Generation of projects for the integration of social groups with special needs of social groups with special needs 5) Strengthening skills for employability 6) Innovation and productivity as an element of the skills to be developed 7) Support collaboration between government and stakeholders to achieve better results in terms of competences 8) Improve public and private financing for competitions

The Tecnologico Nacional de Mexico Campus Tijuana through CIIDETEC aims, within the framework of the 50th anniversary celebrations, to offer the regional community of the different public and private sectors the alternative of certifying the competencies of employees through the Entity of Certification and Evaluation that the registration will be generated before the Mexican Government institution known as CONOCER [10] (National Council for Standardization and Certification of Competences), likewise the Academic Body of the Postgraduate Administration of the Department of Economic-Administrative Sciences has research lines for the design of Sectoral Skills Standards to contribute to the development of the strengthening of the competitiveness of professional talent in the region. In this sense, the project of the Observatory of labor, professional and research competencies of the economic sectors in Baja California as a strategy from

the academy to align its study programs to the relevance of the different knowledge that the business sector demands for employability and competitiveness of the strategic sectors in the CALI-BAJA [11] region on the northern border of Mexico.

2 Framework

Our theoretical framework of reference starts from a research question. What are the elements that determine the effectiveness in the design of dictionaries of professional competences? to close the gap in the needs of business sectors versus educational programs and facilitate training and updating based on training towards training based on alignment processes based on competency standards, traditionally labor competency standards are identified, this project is oriented to the design of standards of professional competences and research, considering each of the 8 levels of competences defined by UNESCO: the Dictionary of Labor Competencies (DCL) for Levels 1 (Primary), 2 (Secondary), 3 (High School, Technical Professional, Basic Technician and Auxiliary Technician), 4 (Technologist) and 5 (Professional License, Technical License, Associate Professional, Higher University Technician); the Dictionary of Professional Competences (DCP) for Level 6 (Bachelor's Degree), and Dictionary of Research Competences (DCI) for Levels 7 (Master's and Specialty) and Level 8 (Doctorate). The methodological innovation proposal generates a new construct for research, which is based on a methodology developed from the academy in a doctoral thesis in 2008 known in Spanish as Quinta Helice Sistemica (QHS) [12, 13] The QHS methodology is characterized by sectoral integration, with representatives of the Government, Universities, Companies, Associations-Unions and Experts-Consultants to develop sectoral agend (ADS); and thereby define the requirements and profiles of standards of professional competencies and research, called levels 6, 7 and 8, according to international guidelines.

The technical groups and sectoral competency management committees develop the roadmap for the design of competency standards and its elements to implicitly define the level of complexity and the hours of training or alignment required for a certification process when establishing the categories of the Competence assessment instrument to be used by evaluators of individual function converted into a competence standard. For the development of the Dictionary of Sector Competencies (DCS) [14], it is necessary to have a Certification and Evaluation Entity, whose leadership is assumed by the National Technological Institute of Mexico. Tijuana Technological Institute campus. The largest technological higher education institution in Mexico and Latin America.

The purpose of the Research and Innovation Center of the Tijuana Technological Institute (CIIDETEC) [15], is to explore the strengths and opportunities that the institution has to offer, as well as a diagnosis of the business and services sector in Tijuana and in the State of Baja California with a view to to be a national and international benchmark. CIIDETEC's approach has several strategic lines of operation to contribute to the different sectors of society.

1. National and International Senior Management
2. Innovation and Technology Transfer
3. Business Consulting and Technological services

4. Observatory and Technological Prospective
5. Development of Specialized Talent

The Specialized Talent Development axis, which has six divisions:

a. SECTORIAL OBSERVATORY Traceability and data mining of social needs (Website - Project registered with TecNM).
b. POSTGRADUATE WITH INDUSTRY Master's and Doctorate (CONACYT option).
c. TRAINING AND CERTIFICATION of Professional Skills and Research.
d. RESEARCH AND CONSULTANCY PROJECTS AD HOC - PRODEP - TECNM - CONACYT projects.
e. SECTORAL ARTICULATION - QHS STUDIES Government - Companies - Associations / Clusters - Consultants.
f. SCIENTIFIC MAGAZINE PROJECT Indexed in Latindex, Springer, Scopus

3 Conclusions

The applied research called and registered at the national level: Observatory for the integration of engineering into the economic development ecosystem of the Baja California peninsula, is a mega project with different objectives that are aligned with each other, which is why the great challenges in The development of an Observatory as a web page from a higher education institution with the vision and mission of contributing to the great challenges and issues in the pipeline for many educational institutions of the different levels, generate the great expectation of results of finding results of the traceability of the children graduated in the different past decades in terms of the economically active population, that is why knowing the monitoring of what the life history is in terms of knowing where they work, in which sectors graduates were integrated, they continued to prepare, they have postgraduate degrees, what type of postgraduate degrees, what type of certifications, generates the great expectation of e data mining for feedback from all systematic sectors of society, also a great source of information for bonding, employability offer and constant feedback to maintain the relevance of study programs aligned to the requirements of each sector. Likewise, strategic planning with policy initiatives and public programs to strengthen the opportunities for the well-being of society and the prosperity of future generations.

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Application of Blockchain Technology for Educational Platform

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Abstract. Nowadays, huge amounts of data are generated every second, and a quantity of that data can be defined as sensitive. Blockchain technology has private, secure, transparent and decentralized exchange of data as 'native'. It is adaptable and can be used in a wide range of Internet-based interactive systems in academic and industrial settings. The essential part of programmable distributed ledgers such as Ethereum, Polkadot, Cardano and other Web 3.0 technologies are smart contracts. Smart contracts are programs executed on the global blockchain, the code is public as well as all of the data managed within the transactions, thus creating a system that is reliable and cannot be cheated if designed properly. In this paper, in order to make the educational system more transparent and versatile we will describe an educational learning platform designed as a distributed system.

Keywords: Blockchain technology · Data security and privacy · Smart contracts · Educational platform

1 Introduction

1.1 Problem with Centralized Systems

Areas associated with database systems have a wide range of industrial application; finance, academia, messaging services, healthcare etc. These systems are mainly deployed in a centralized manner, meaning a single entity has major decision-making and authority. So, it is possible that a trusted party goes rogue and seizes control of data governance.

Another problem with centralized services is the operational cost and user capacity; namely, with the industry 4.0 revolution and the ever-increasing number of user and devices traditional server-based systems will not be able to provide a continuous service. Internet of Things (IoT), Machine Learning, Artificial Intelligence (AI), Machine-to-Machine communication and others technologies will require immense resources and availability, and in this case centralized systems have scalability limitations as the future massive demand expansions of computing power [1]. Traditional database applications can have a decent level of security with additional security operations such as firewalls,

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 1283–1287, 2022.
https://doi.org/10.1007/978-3-030-85540-6_165

however the centralized nature and the lack of control from the user side rises concern about real level of privacy. Still, in centralized systems there is always a single point of failure, regardless of backup databases. Also, it is known that companies with large amounts user data sell this data without users understanding what is happening, thus the implementation of blockchain technology as data security and privacy level is important to protect that data.

1.2 Smart Contracts

A commonplace everyday mechanism in the life of humans are contracts; a piece of data and rules that uphold promises between two untrusting parties in a fair manner. The key concept of Smart Contracts was introduced in late 1990s by Nick Szabo with his initial idea to secure relationships over computer networks [2].

Smart contracts are programs executed on the global blockchain, the code is public as well as all of the data managed within the transactions, thus creating a system that is reliable and cannot be cheated if designed properly. Unlike traditional software, smart contracts are immutable, meaning once deployed, the code contained within a contract cannot be changed, unless if it is deployed as a new instance.

Likewise, another key concept is that they are deterministic, meaning that the outcome of execution of a smart contract is the same for every executor within the given context of the transaction. These rules and standards are creating a safe "middleman" ecosystem where manual involvement of a Trusted Third Party (TTP) between two parties is completely eliminated and automated, aside small transaction fees used to power the network's holders. Further, we are aiming to use the most economically and ecologically efficient system in order to reduce cost and the global carbon footprint; therefore, we also compared several consensus mechanisms such as Proof-of-Work (PoW), Proof-of-Stake (PoS) and Proof-of-Authority (PoA) [3].

Blockchain technology has private, secure, transparent and decentralized exchange of data as 'native'. It is adaptable and can be used in a wide range of Internet-based interactive systems in academic and industrial settings.

2 Methods and Approach in System Development

2.1 Simulation

Students were given the task of managing digital marketing activities for a fictitious smartphone brand that had a limited range of three phones with varying technical characteristics and a defined target demographic. The first round of the simulation is a test round, which allows students to become familiar with the interface after it has been set up. Various random events may occur during the simulation, such as the need for sales promotion support, a good cause, a distribution issue with the product, or a technical fault with the product, to which students must respond appropriately.

The Internet Marketing simulation was created as a three-step process: planning, execution, and reporting. The admin user, or professor in this example, has access to the backend controller system and can make changes to the rules before the simulation cycle begins. These rules are open to the public and do not affect game fairness because they are based on previous smart contract regulations.

2.2 Planning Stage

The planning stage focuses on budgeting, keywords, and targeting possibilities. Each team (or, in this case, Blockchain node) must decide on money allocation and spending for each turn. Product, brand, and other communication channels and activities must all be divided within the weekly budget. Additionally, as is the case in reality, more targeted expenditure (e.g., limited to one product and/or fewer channels/activities) is more efficient. This stage was entirely built using JavaScript technology, and it can be accessed from the application's front-end.

2.3 Execution of the Plan

Students can make some minor adjustments to the plan's implementation to improve the advertising effort. The keyword (or numerous keywords, depending on the channel) must be chosen by each student or team. Depending on the style of class delivery, this phase is done on a daily or weekly basis. Students can clearly identify their target audience in order to optimize the total promotional effort (s). Targeting is a platform-specific term that applies to promotional efforts. For success, the right mix of messaging strategy and targeting is critical.

2.4 Reporting Stage

Students receive official reports (digital platform insights/analytics) and some less formal reports once the round/turn is completed (sales force feedback). Students will have to pay a set amount of money for the market report (which will include statistics on the competition and customer preferences). This backend process is built using distributed Blockchain technologies instead of a single centralized database, and we've developed Blockchain-based reporting.

3 Technology

One of the key goals was to focus on decentralization and differential privacy as privacy assurances for both students and academics. The system is divided into three primary sectors, each of which has specific responsibilities and is linked by an intermediary level that manipulates and shares data.

In comparison to the EVM (Ethereum Virtual Machine) cost of transactions, we created a functioning prototype that employs the underlying technologies that allow free transactions per se [8]. Nonetheless, by simply changing the target network and altering some communicational variables, the system can be transferred to any EVM-based blockchain network (Fig. 1).

As it can be seen from the figure one, our system comprises of three interconnected independent parts; the first is the frontend of the application which handles all user communication, the second part is.NET API which is responsible for all heavy-weight computational efforts, and finally we have the blockchain part where crucial data exchange happen.

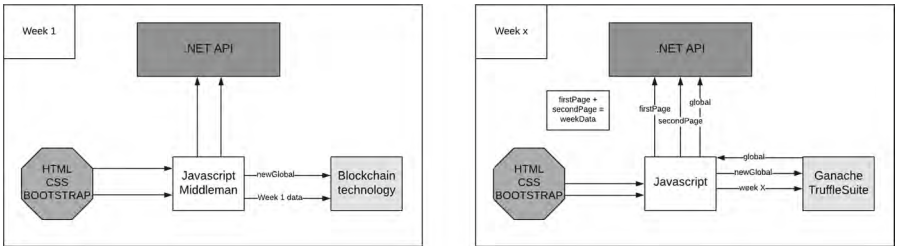


Fig. 1. Key communication exchange

3.1 Truffle Suite

Truffle Suite is a development environment that includes all of the tools needed to complete the whole development process of a blockchain platform. Truffle handles contract artifact management and provides support for easy deployments, library linking, and complicated Ethereum applications. It also allows you to write automated tests in both JavaScript and Solidity for smart your contracts. From dependencies in our deployment, we were using Truffle v5.0.2 (core: v5.0.2) and truffle-contract v3.0.6.

3.2 Ganache

Ganache is a local in-memory Ethereum blockchain environment that mimics the behavior of the distributed ledgers in the real world. The system displays the current state of all accounts, including their addresses, private keys, transactions, balances, and the log output of Ganache's internal blockchain, which includes responses and other important debugging data. Furthermore, ganache has additional mining features, including the ability to modify block times to best suit your development needs and examine all blocks and transactions to learn more about what's going on behind the scenes. For development we have used Ganache v2.4.0 with JSON Remote Procedure Call (RPC) server setup, the price of each unit of gas is set up at 20000000000 Wei, the gas limit is 6721975 units and the hard fork is set to Petersburg.

3.3 Web3.js

Web3 is a collection of protocols aimed at making the internet more decentralized, verifiable, and secure. The web3.js library is a set of modules that allow Ethereum ecosystem functionalities to be connected to traditional applications. We also implemented web3.js v1.3.0 as a JavaScript web provider to link Truffle Suite and Ganache to the browser.

3.4 MetaMask

MetaMask provides a key vault, secure login, token wallet, and token exchange as a browser extension and a mobile app, giving you everything you need to manage your digital assets. MetaMask is a browser plugin that acts as an Ethereum wallet, enabling

websites to request Ethereum accounts and thereby run Ethereum decentralized applications (dApps). MetaMask does this by including a provider object that identifies an Ethereum user, resulting in an API that can read data from the blockchains. In our system, we have used the MetaMask v4.0.2.

3.5 Solidity

Solidity is an object-oriented programming language with a statically typed syntax used for smart contract development on a variety of blockchain systems, the most prominent of which is Ethereum. We used solidity v0.5.0 for our system.

3.6 Additional Technologies

The API handles the most data and is the primary method for sales force calculations. JavaScript calls are performed to the API via specific controllers during the simulation, which may handle user interaction with or without blockchain to do initial computations and conclude the weekly turn report.

For the .NET Core version, the API business logic calculation subsystem uses C# with Microsoft (R) Build Engine version 16.2.32702 + c4012a063 and the project SDK Microsoft .NET.Sdk.Web with the netcoreapp2.2 target framework.

4 Conclusion

One of the key objectives of our system was to place a strong emphasis on privacy guarantees for both students and teachers, such as decentralization and differential privacy. The instructor-accessible admin tools, as well as the user panel and other settings based on distributed Blockchain reporting, allow for a high level of customization in our program. Furthermore, our application may function in multi-user mode, allowing students (or teams of students) to compete against one another.

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Information and Probability Models of Students' Independent Work in Modern Educational Technology

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Abstract. The paper presents mathematical models of students' independent work, which is the dominant component of the educational process, both in its volume and in its didactic significance. These models are based on probability theory and set theory. As part of the research of the independent work of students in the conditions of the information and educational environment at university, a pedagogical experiment was conducted at Kuban State Technological University and Krasnodar Cooperative Institute (branch) of the Russian University of Cooperation, both located in the city of Krasnodar, Russia. The undergraduate students involved in the research entered university in the period from 2014 to 2016. As a result of the analysis of empirical data, a matrix reflecting the relationship between the success of students' classroom work and independent work has been obtained. The authors have developed information and probability models that reflect the relationship between classroom and independent work of students.

Keywords: Information and probability models · Students' independent work · Educational technology

1 Introduction

The problem of increasing the efficiency of university students' independent work is now vital [1–4]. The most important task of higher education is to teach a person independence: the ability to learn (that is, to obtain knowledge independently) is the most important factor in adaptation to the present-day dynamic society.

In the context of informatization of education, educational environments are transformed into information and educational environments, while pedagogical technologies become didactic information technologies. The most advanced educational technology is blended learning [4–6] that optimally combines the advantages of full-time and distance learning.

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 1288–1293, 2022.
https://doi.org/10.1007/978-3-030-85540-6_166

Informatization of education is not limited to the use of computer technologies in the educational process, but presupposes this process to be reorganized with the introduction of new opportunities into it, which cannot take place outside the conditions of the information and educational environment [7–10]. The aspects to be specially considered in this respect are, first of all, the individualization and differentiation of education (design and implementation of individual educational routes) with monitoring the quality of education in general and the effectiveness of education in particular. Pedagogical monitoring needs criteria for the quality of education and models of the learning process, including mathematical ones [5, 8]. This is due to the fact that pedagogical monitoring includes forecasting the students' educational activity and the search for ways to bring this activity to a new level. All of the above is true for both classroom and extracurricular (or, in other words, in-class and out-of-class) independent work of students.

At present, the Rasch model is known as an achievement in the mathematical modeling of students' learning activities:

$$p = \frac{e^{B-Y}}{1 + e^{B-Y}} \tag{1}$$

where p is the probability that a student with a level of knowledge B will cope with the task of difficulty Y (with both values expressed on the logit scale), e is an exhibitor function. The model has been refined by some specialists [5]:

$$p = \frac{e^{H-Y}}{1 + e^{H-Y}} \cdot g(S, s), \tag{2}$$

where H is the efficiency of managing one's own knowledge (the probability of the successful application of the established knowledge by the student in educational activity, expressed on the logit scale), S is the set of elements (portions) of the knowledge bank that are objectively necessary for performing a pedagogical task (solving a problem), s is is the set of such elements formed by the student. Obviously, $g(S,s) = 1$ if $S - s = \text{Ø}$ (Ø is the symbol of the empty set), and $g(S,s) = 0$ if otherwise.

At the same time, solving a problem (performing a pedagogical task) is only a "unit" of the learning process. First, the student's educational activity is a systemic process subordinated to didactic goals (first of all, the formation of competencies and personal and professional qualities). Secondly, the student's independent work is not limited only to solving problems independently (performing tasks). A very important element of educational activity is the acquisition of new educational and scientific information, which is characterized by the level of difficulty [6, 8, 10]. Thirdly, the student's independent work is characterized not only by efficiency, but also by independence, reflexivity, the use of computer technologies and competence-oriented teaching methods [3, 5, 11]. Moreover, in order to increase the effectiveness of blended learning, it is necessary to ensure a close connection between classroom and extracurricular independent work of students. The solution to this problem is difficult without the models of the relationships between classroom and extracurricular independent work of students. One of the authors of this article has proposed criteria for the relationship between classroom and extracurricular independent work of students, highlighted the levels, proposed methods for their diagnostic assessment [3]. These are the following parameters.

The first criterion is

$$K_1 = \min\left(R_{cl},\, R_{EIW}\right), \tag{3}$$

where the arguments are, respectively, the success of classroom and extracurricular independent work (to be expressed on one linear scale).

The second criterion is

$$K_2 = \frac{\sum\limits_{i=1}^{card(Q)} F_i}{\sum\limits_{j=1}^{card(q)} f_j}, \tag{4}$$

where q is the set of knowledge and skills formed in the course of classroom work, Q is the set of knowledge and skills formed in the course of independent work, F_i is the difficulty level of the i-th element from the set Q, f_j is the difficulty level of the j-th element from the set q. The methods to assess the complexity of the scientific information being mastered were created earlier [6].

The third criterion reflects the influence of classroom work on independent work:

$$K_3 = card(l). \tag{5}$$

The fourth criterion reflects the impact of independent work on classroom work:

$$K_4 = card(L). \tag{6}$$

The fifth criterion reflects the indirect connection between classroom and extracurricular independent work:

$$K_5 = card(\mu). \tag{7}$$

Here l is the set of information and semantic links between the elements of the sets q and Q, L is the set of links between the elements of the sets Q and q, while the general set of semantic links is $\lambda = l \bigcup L$.

At the same time, the success of the classroom work of students is not a "guarantee" of the success of extracurricular independent work. It is obvious for the authors that the relationship between the success of classroom and extracurricular independent work of students has a probabilistic nature. The purpose of the research is to develop information and probability models of students' independent work. The object of the research is the students' independent work in the conditions of the university information and educational environment, while the subject of the research is the information and probability models of independent work.

2 Methods

The methodological foundations of the research are the sociological approach (that considers the information and educational environment as a complex of opportunities for students' development), the competence approach (that proclaims not the formation of knowledge and skills but the readiness for their effective management as the target reference point of the educational process), the systemic approach (that considers mathematical models of students' independent work as a scientific support of pedagogical monitoring, the educational electronic portfolio of a student as a condition for the success of pedagogical monitoring, and monitoring as an information mechanism for pedagogical support of students' educational activities), the personality-oriented approach (that considers students' independent work as a mechanism for the development of their personalities), the qualimetric approach (that proclaims the need for multicriteria diagnostic assessment of the success of the students' educational activity) and the probabilistic-statistical approach (that considers the educational activity of the student, including independent work as a stochastic process). The research methods are as follows: the analysis of scientific literature and best practices of pedagogical support of students' independent work, modeling, methods of the set, graph and relation theory, qualimetry methods (theory of latent variables), methods of informetrics, survey methods, pedagogical experiment, methods of probability theory and mathematical statistics, and methods of linear algebra.

The leading methodological basis was the probabilistic-statistical approach. Social systems (the educational environment being one of them) are stochastic, i.e. obeying the laws of probability theory. Consequently, mathematical models of students' educational activities, including independent work, should be informational and probabilistic [12].

The pedagogical experiment was carried out at an engineering university – Kuban State Technological University – and at an economic university – Krasnodar Cooperative Institute (branch) of the Russian University of Cooperation – both located in the city of Krasnodar in Russia. 2748 students who enrolled in the years 2014, 2015 and 2016 were subjected to the survey. The authors developed a matrix based on the analysis of empirical data and reflecting the relationship between the success of classroom and independent work of students. The integrated level of success in classroom and extracurricular independent work of students was diagnosed in accordance with the previously developed methodology [5].

3 Results

The analysis performed at the empirical stage of the research made it possible to develop a probabilistic matrix of the relationship between the levels of classroom and extracurricular independent work of students (Table 1). The sample can be considered representative, since students of various educational profiles (academic majors) and areas of professional training are taken into account.

Table 1. Matrix of relationship between the levels of levels of classroom and extracurricular independent work of students.

Level of independent work	Level of classroom work				
	Low	Average	Appropriate	High	Very high
Low	100%	60.5%	15.5%	0%	0%
Average	0%	39.3%	35.1%	16.1%	8.1%
Appropriate	0%	0%	44.4%	35.1%	21%
High	0%	0%	4.86%	40%	29.1%
Very high	0%	0%	0%	8.6%	41.7%
Total	100% (314 students)	100% (480 students)	100% (884 students)	100% (613 students)	100% (457 students)

The results shown in Table 1 should be understood as follows. For example, out of 613 students with a high level of classroom work, 99 students (16.1%) are characterized by an average level of extracurricular independent work, 215 students (35.1%) – by an appropriate level, 246 students (40%) – by a high level, and 53 students (8.6%) – by a very high level of extracurricular independent work.

Nevertheless, this table reflects the probabilistic-statistical relationship between the levels of classroom and extracurricular independent work of students, if electronic educational resources (in general, distance learning technologies) are not used in independent work. All surveyed final-year students used electronic educational resources (in general, distance learning technologies), and the probabilistic relationship looks different (Table 2).

Table 2. Matrix of relationship between the levels of levels of classroom and extracurricular independent work of students using electronic educational resources.

Level of independent work	Level of classroom work				
	Low	Average	Appropriate	High	Very high
Low	94.9%	54.2%	8.4%	0%	0%
Average	5%	41.3%	35.3%	36.9%	0%
Appropriate	0%	4.5%	48.3%	27.7%	10.2%
High	0%	0%	7.86%	49.4%	40.2%
Very high	0%	0%	0%	18.1%	49.6%
Total	100% (277 students)	100% (419 students)	100% (916 students)	100% (623students)	100% (513 students)

As it can be seen, the use of distance learning (more precisely, electronic educational resources in blended learning) creates conditions for the successful independent work of students. It is also observed that the informatization of the educational process contributes to the decrease in the share of students with low levels of classroom work. This makes one more positive side of informatization in education quite obvious.

4 Conclusion

The research prospects are connected with the development and verification of mathematical models reflecting the relationship between the probability of students' successful mastering of new educational and scientific information (response variable) and the students' existing knowledge system (a factor whose diagnostic assessment method is presented by [6]). They can be applied not only in higher (undergraduate and postgraduate) education, but also at the preceding education levels so that prospective university students could be better prepared for their professional training.

Acknowledgments. The research was carried out with the financial support of the Kuban Science Foundation in the framework of the scientific project No. IFR 20.1/36.

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Towards Requirements Related to Future CCAM Services for Road Usage Optimization

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Abstract. Road damage on highways and freeways lead to numerous construction sites and maintenance activities every year, causing congestion, increased environmental pollution and costs. In addition, road damage exposes road users to an increased risk of accidents. The EU project ESRIUM aims to help reducing both the number of road works and the associated problems by using new digital services for intelligent road infrastructure use and predictive maintenance. The aim of this study is the presentation of four use cases and the elaboration of non-technological requirements of the offered digital services, which should lead to a deep understanding of the requirements of all stakeholders in the early phase of the project.

Keywords: Autonomous driving · CCAM · Predictive maintenance · EGNSS · User acceptance · Technology acceptance

1 Introduction

Congestion, air pollution, increased travel times and costs are the main problems caused by road damage and affect many travellers every day. In addition to these challenges, road damage also poses a significant safety risk, and can lead to vehicle damage as well as road accidents. The EU project ESRIUM [1] addresses these problems and aims at increasing the safety and resource efficiency of mobility on the road. The key innovation will be formed by a homogeneous, accurate and recent digital map of road surface damage and road wear. Road wear data in combination with machine learning algorithms will be used for predictive maintenance purposes to anticipate potential road damages and initiate appropriate countermeasures. In addition, services such as providing road users with EGNSS (European Global Navigation Satellite System) correction data via C-ITS (Cooperative Intelligent Transport Systems) messages aim at adjusting the driving path (in lane and between lanes), resulting in lower degradation of the road surface and therefore fewer construction sites. The provision of such services as well as the interconnection of vehicles with infrastructure serves as another building block for CCAM (Cooperative, Connected and Automated Mobility) [2, 3].

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 1294–1301, 2022.
https://doi.org/10.1007/978-3-030-85540-6_167

This study presents selected results of the first project phase of ESRIUM, which includes both, detailing various use cases for different stakeholders for the illustration of potential ESRIUM services as well as the definition of non-technical requirements for the realization of their respective functionalities. The aim of this phase is to understand the requirements of the stakeholders and to map them with the aid of a requirements list. The requirements are then to be taken into account in the development of the ESRIUM services in order to optimize the interaction between humans and the system and thus increase user and technology acceptance. However, as different stakeholders need to be considered when formulating use cases and functional requirements, e.g. end users, original equipment manufacturers (OEMs) and road operators, the requirements for the ESRIUM system require a methodical approach to formulate requirements taking into account diverse stakeholder needs.

2 Methodology

Use Case und Service Definition
Due to the Covid-19 pandemic situation, the formulation and validation of the ESRIUM use cases was primarily conducted in online meetings. In general, a stepwise approach was implemented:

(1) First of all, we performed a use case analysis in order to develop a detailed description of the services that can be offered by ESRIUM. Within this analysis, four application scenarios of ESRIUM services including their potential target groups and application requirements, as well as the respective challenges were defined and developed.
(2) This project internal view has been validated during a bilateral workshop with the key customer (road operator) of the ESRIUM services
(3) Following this bilateral workshop and the integration of related feedback in an advanced version of the use cases, another internal validation process with all project partners started to develop consensus within the diverse and multidisciplinary team of the ESRIUM project.
(4) Finally, an external validation of the use cases with ASECAP (European Association of Operators of Toll Road Infrastructures) members and the integration of related feedback into a final version of the use cases is in progress.

Within the development of the use cases, the project team specified potential application areas for ESRIUM services and relevant system components. The planned functionalities and development steps identified in the process can be listed as follows:

- Road sensing and damage mapping system development
- Road damage map/road wear map creation
- C-ITS based RTK (Real Time Kinematic) correction message standard development for EGNSS

- An intra- and in-lane position recommendation system concept and prototype demonstration utilizing the Road Wear Map information
- Development of ADAS/AD (Advanced Driver Assistance Systems and Autonomous Driving) functions that are capable to utilize the routing and position recommendations
- Integration of Galileo OS NMA (Open Service – Navigation Message Authentication) based position authentication

The above-mentioned features to be implemented in the course of the project were subsequently used as a basis for identifying potential target groups. In doing so, three key target groups were identified, namely (1) road operators, (2) B2B customers like OEMs, wear map providers and navigation service providers and (3) end users (e.g., truck drivers, logistics service providers, automated vehicle owners, etc.). As a result, both the planned functionalities as well as the identified target groups were used to formulate appropriate application scenarios, with a total of four use cases being formed. All four use cases have been described in detail with the following structure (Table 1):

Table 1. Structure of use case description

Use case Description	
Use case #	<Defined use case ID>
Name	<Title of the respective use case>
Preliminary pain points	<Pain points addressed by the ESRIUM service>
Short description	<Textual description of the use case>
Preliminary target group	<Target group of the respective ESRIUM service>
Demo-site	<Site for use case demonstration>
Key assumption	<Key assumptions necessary for service realization>
Involved stakeholder roles	< Stakeholders contributing to the service realization >
Involved project partners	<Project partners contributing to the service realization>
Realization prerequisites	<Prerequisites regarding physical and digital infrastructure as well as data availability>
Challenges/Barriers/Open issues	<Potential obstacles of points still to be clarified>
Target/Evaluation metric	<Methods for measuring the results of the use cases>
Preliminary USP	<Unique Selling Point created by the use case>

Non-technical Requirements

The methodological approach for the elaboration of the non-technical requirements (NTR) was also carried out in a stepwise approach (Fig. 1).

(1) Items and constructs from the technology acceptance models UTAUT [4] and TAM3 [5] were examined and a preliminary list of non-technology requirements

for ESRIUM services was derived. The final list will serve as a basis for future measurements of user acceptance of ESRIUM services and shall help to optimize human-system interaction and thus increase user and technology acceptance.

(2) In addition, the non-technical requirements were associated with

   a. The use cases defined
   b. Relevant Stakeholders (e.g. road operator, truck driver, logistics operator, OEM in the roles as customer or supplier of the respective services)
   c. ESRIUM-related subcategories considered in the project proposal (user acceptance, convenience, traffic safety, traffic efficiency, environment, organization from data gathering to service provision, legal issues including privacy).

(3) The preliminary NTR list was then revised in an internal validation process during a workshop with numerous project partners (e.g. road operators, technical experts) to ensure a multidisciplinary view from different perspectives.

(4) Finally, an external validation of the NTR list will be performed by ASECAP members and the feedback received will be incorporated into a final version.

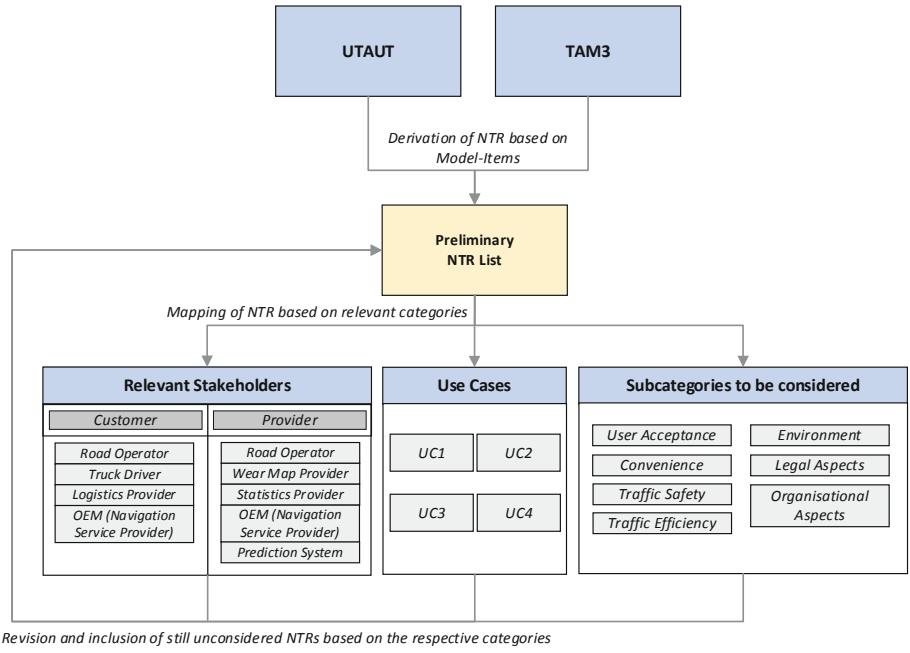


Fig. 1. Process for the definition of non-technical requirements

Based on the methodology described above, non-technical requirements were developed, which can be described as follows (Table 2):

Table 2. Evaluation categories of non-technical requirements

Category	Required information
ID	Defined non-technical requirement ID
Title	Title of the respective non-technical requirement
Description	Textual description of the non-technical requirement
Topic focus	Assignment of the non-technical requirements to the following main topics: user acceptance, convenience, traffic safety, traffic efficiency, environment, organization from data gathering to service provision, legal issues including privacy
Customer	Stakeholders who are in the role of the customer for the respective non-technical requirement
Provider	Stakeholders who are in the role of the provider for the respective non-technical requirement
Use case	Relevant use cases for the respective non-technical requirement

3 Results and Discussion

Based on the methodological approach for the development and validation of various potential application scenarios of the ESRIUM services, the following use cases were developed.

- UC1: AI-based road damage prediction to support enhanced road maintenance planning
- UC2: Routing Recommendations based on the road wear map, provided via C-ITS messages (Manoeuvres within lane and between lanes)
- UC 3: C-ITS Message 'GNSS-correction data' provision
- UC 4: Wear map content provision

UC1 describes an AI-based road damage prediction system based on current road wear data. Based on the predicted onset of road damages road operators can set-up a derived predictive road maintenance and action plan to proactively reduce more severe road damages, which leads to overall maintenance reduction, reduction of CO_2 emissions due to avoidance of construction zones and financial benefits due to enhanced road maintenance planning.

Based on early damage prediction, road operators can derive an enhanced action plan to proactively avoid severe road damages. As an example, UC2 describes routing recommendations such as lane changes or in-lane offset recommendations for drivers. UC2 therefore serves towards the avoidance of severe road damages and critical safety-related situations (e.g. vehicle side damage avoidance) as well as a contribution for the equal utilization of the road to prevent unequal road surface wear.

The implementation of routing recommendations, especially in-lane offsets, can only be realized on the basis of precise position data of the respective vehicles. As a result, EGNSS-based correction data for enhancing the positioning accuracy of vehicles

is needed. The precise positioning allows following the lane change or in-lane offset recommendations accurately and therefore avoid road wear. Providing the EGNSS correction data via C-ITS also acts as an additional source of correction information and adds redundancy for requirements of functional safety for automated mobility.

UC4 describes the provision of the road wear detected via a road wear map, and is intended to be available to stakeholders such as navigation service providers, OEMs and road operators. It allows new routing possibilities such as the selection of the most convenient route, resulting in enhanced driver convenience and traffic safety by proactively avoiding road wear geolocated in the road wear map.

As described above, the individual use cases are not independent of each other, but are partly based on the results of other use cases. Similarly, the use of individual use cases is not the same for all stakeholders. As an example, road operators use road damage prediction and maintenance planning services to make routing recommendations based on GNSS-corrected vehicle positions. Both the routing recommendations and the GNSS correction data are thereby sent to end users via C-ITS messages. At the same time, by providing the road wear map based on UC1 and UC4, end-users can make general routing decisions such as choosing the most convenient route to drive on. A visual representation of the individual use cases and their interrelation and connection to the relevant stakeholders can be seen in the Fig. 2 below.

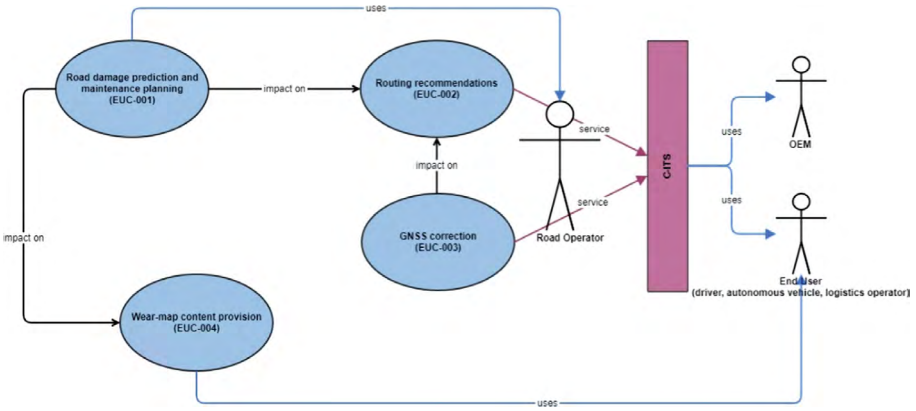


Fig. 2. ESRIUM use cases interrelations and result usage

Non-technical Requirements

Within the internal validation process, 24 non-technical requirements related to the planned ESRIUM services were defined. The subcategories user acceptance and convenience were addressed in five non-technical requirements each, followed by traffic safety, organization form data gathering to service provision and legal issues including privacy with four non-technical requirements each. The subcategory environment is addressed in two non-technical requirements. Due to the length and current status (under external revision) of the entire list, we have refrained from presenting the complete list and present selected examples in the following Table 3.

Table 3. Preliminary list of non-technical requirements (examples)

ID		ENR-001	ENR-002
Title		Reduction of construction sites	Clear lane change recommendations
Description		I would like to know how many construction sites per year I can save by using the forecast model	Lane change recommendations for manual maneuvers must be clearly understandable and easy to learn
Subcategories	User acceptance		X
	Convenience		
	Traffic Safety		
	Traffic Efficiency	X	
	Environment		
	Organization from data gathering to service provision		
	Legal issues including privacy		
Customer	End user (truck driver)		X
	End user (logistics provider)		
	Road operator	X	
	Navigation service provider/OEM		
Provider	Wear map provider		
	Prediction system		
	Road operator	X	
	Navigation service provider /OEM		X
	Statistics provider	X	
Use case	UC1	X	
	UC2		X
	UC3		
	UC4		X

Example ENR-001 illustrates the mandatory requirement of given traffic safety before recommendations for lane changes or offsets within the lane are sent to the

vehicle. ENR-002 refers to end-user acceptance of lane change or in-lane offset recommendations and specifically addresses ease of use and comprehensibility as relevant aspects of technology acceptance (cf. TAM3 [5], UTAUT [4]).

4 Conclusion and Further Research

The EU project ESRIUM aims to contribute to reducing both the number of road works and the associated problems on motorways by using new digital services for the intelligent use of road infrastructure and predictive maintenance. For the purpose of realising these very goals, different use cases were developed within the project, which were validated both internally and externally with selected stakeholders. The use case descriptions serve as a foundation for the future development, as well as testing and assessment of tasks within the project. Moreover, the described use cases serve as a basis for the formulation of both technical and non-technical requirements as well as system interface design aspects for ESRIUM services.

A preliminary list of 24 non-technological requirements for ESRIUM services was formulated taking into account state-of-the-art acceptance models (TAM3, UTAUT). After external validation, this list will serve as a basis for the creation of adapted technology acceptance models and items to measure the user and technology acceptance of the different stakeholders. The stakeholder survey will be conducted as part of initial field tests on test routes. The results of the survey shall help to optimize the human-system interaction of ESRIUM services and subsequently improve user and technology acceptance.

Acknowledgments. ESRIUM has received funding from the European GNSS Agency under the European Union's Horizon 2020 research and innovation programme under grant agreement No 101004181.

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Design of a Water Control System Installed in the Tree Trunk in Forest Fire Environment

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Abstract. This article presents a numerical study on the thermal response of a trunk tree, in a forest fire environment, provided with an incorporated water control system. This numerical control system activates the water system when the temperature rises above 60 °C. The numerical model of the trunk tree is based on energy balance integral and differential equations. The virtual trunk tree geometry was developed used adaptive mesh generation. The numerical simulation was made for a fire front propagation at a constant fire spread rate of 0.01 m/s. The temperature distribution in the pine tree trunk, obtained for a flame temperature of 500 °C, will make it possible to identify the areas of the trunk tree that will reach temperatures that will trigger the control system. The results show that the water system will mostly be activated when the fire is on the upstream side of the tree trunk.

Keywords: Fire front · Forest fire · Numerical simulation · Tree thermal response · Adaptive mesh generation

1 Introduction

Portugal has about 39% of its territory occupied by forests [1]. It is one of the countries in Europe with the highest incidence rate of forest fires [2, 3], with more than 20000 occurrences having been recorded for years [4]. This high number of forest fires, some with large extensions of burnt area, have caused significant environmental and socio-economic negative impacts [5]. Therefore, the study of the thermal behavior of forest fires as well as their consequences on the survival of affected trees is justified. The process of direct tree death from fire is the cambium necrosis via heat transfer, by conduction, convection and radiation, to the crown, stem and root tissue [6]. The lethal threshold for trees is reached for temperatures equal or above to 60 °C, although longer exposure at lower temperatures can also cause tissue death [7]. Early detection and combat in the early stages of forest fires is very important to limit its impacts. Early detection and

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 1302–1309, 2022.
https://doi.org/10.1007/978-3-030-85540-6_168

combat in the early stages of forest fires is very important to limit its impacts. In this way, automatic fire detection and firefighting systems previously installed in forest areas can make a significant contribution to minimizing burnt areas and the risk to human lives [8].

In this work it is applied a thermal response numerical model to estimate the temperature evolution inside the trunk tree towards a forest fire. This numerical model is founded on the human body geometry, applied on the human thermal response numerical model [9–11]. Knowing the evolution of the temperature inside the tree, it is possible to identify which points will reach the lethal threshold [7]. This situation can then be defined as the moment when the fire in the vicinity of the tree must be extinguished.

The objective of this work, applying an adaptive mesh generation model, is to obtain the evolution of the field temperature in the tree before and after the fire is extinguished. The lethal threshold defines the point at which the fire extinguishing system will operate. The knowledge of these field temperature transient conditions will allow to establish the extent of damage caused to the tree and the response time of the fire extinguishing system. The forest fire is represented by a front fire.

2 Numerical Model

The differential energy equations and the adaptive mesh are used by the numerical model to assess the thermal behavior inside the tree, whose trunk is composed of bark and cambium. The model considers energy balance equations at the boundary between the tree and the surrounding environment as follows:

- Heat conduction with the interior of the tree;
- Heat convection (natural, forced and mixed) between the tree surface and the air environment;
- Radiation between the tree surface and the surrounding surfaces (fire front, fuel bed and sky).

A procedure related to heat exchanges between surfaces of building compartments is used in the radiative exchanges determination. This procedure is applied in the thermal response model of buildings with complex topology and cabins of vehicles. Its application is presented in the studies of Conceição et al. [12–15] and Conceição and Lúcio [16–18]. The temperature distribution inside the tree is evaluated by a finite differences implicit model.

The tree surface contours were developed by a numerical adaptive mesh generation model using the method of finite differences. This mesh generation considers the conversion of a physical space into a computation space done by two Poisson's type elliptic partial differential equations. The adaptive mesh generation used in the present work is shown in Fig. 1. Wind speed, fire front conditions (dimensions, inclination, flame temperature, fire rate spread), tree dimensions, initial distance of the fire front from the tree, lethal threshold and other initial conditions are the input data of this model.

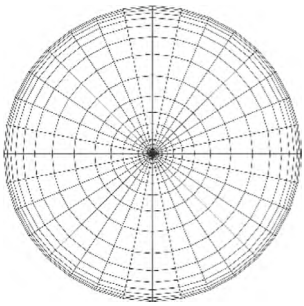


Fig. 1. Adaptive mesh generation used (33 × 20 grid points).

3 Numerical Methodology

The evolution of the field temperature distribution in a tree is obtained as result of the numerical simulation done in this work. The numerical simulation is carried out considering two situations: the fire front propagation occurs without and with the action of the extinguishing system. The numerical extinguishing system consists of a sprinkler located close to the tree that will be activated by a control system operated by a signal received from the temperature sensor of the first point that reaches the lethal threshold. The operating radius of the sprinkler water jet was considered equal to 2 m. Figure 2 shows the progression of the fire front in red, the sprinkler operating radius in yellow and the tree in black. The fire front, within the sprinkler's range of action, is only extinguished when the temperature in one of the points of the tree reaches 60 °C.

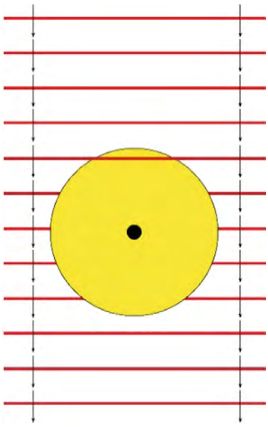


Fig. 2. Operating scheme of the fire extinguishing system. In red, the progression of the fire front; in yellow, the operating radius of the sprinkler; and in black, the tree.

The numerical simulation is characterized by the movement of a fire front at a constant fire spread rate of 0.01 m/s from a distance of 5 m upstream of the tree. The tree is represented by its trunk with a height of 2 m and an external diameter of 0.3 m. The

fire front has a tilt angle of 45°, 4 m wide, 2 m high and an average flame temperature of 500 °C. The environmental conditions are characterized by a wind speed of 0.1 m/s, an air temperature of 20 °C and an air relative humidity around the tree of 50%. The temperature distribution was obtained at 33 points (P) equidistant distributed along the external surface (bark) of the tree trunk in a plane located at a height of 2 m and at 20 points (Q) distributed along the radius of the tree trunk, as shown in Fig. 3.

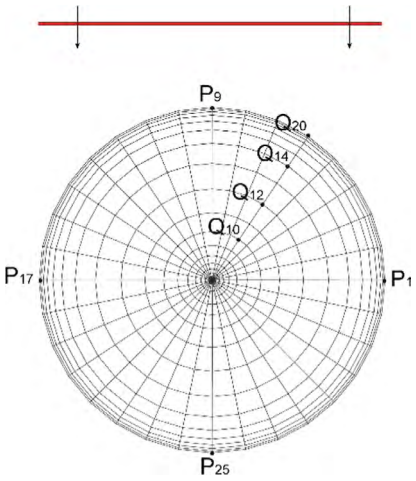


Fig. 3. Location of 33 P-points on the outer surface of the tree trunk and of 20 Q-points inside the tree trunk. The red line represents the progressive fire front.

4 Results and Discussion

The evolution of the field temperature distribution in the surface (points P1 to P33) of the tree trunk is shown for the cases without and with the operation of the fire extinguished system in, respectively, Fig. 4a) and Fig. 4b). In Fig. 4, the red dashed line represents the lethal threshold (TP $\leq$ 60 °C). The evolution of the temperature distribution in the points Q1-Q20 located on the lines of the tree trunk radius is shown in Fig. 5 and Fig. 6 for lines containing, respectively, the points P9 and P25 (please, see Fig. 2 and Fig. 3). The points a) and b) are related, respectively, to the cases without and with the operation of the fire extinguished system. In Fig. 5 and Fig. 6, the red dashed line represents the lethal threshold (TQ $\leq$ 60 °C).

During its progression, the fire front initially affects the side facing upstream rather than the side facing downstream of the tree trunk. Due to the inclination of the fire front, points located on the surface of the upstream side of the tree trunk reach the highest temperatures. The highest temperature, 182.6 °C, is obtained at point P9 after 400 s of simulation time. Point P9 is the first point to reach the value of 60 °C, which happens after 260 s of simulation time, that is, when the top of the fire front is about 1 m from the tree trunk. At this moment the fire extinguishing system starts to operate. Then, it is

verified that the temperature at all points of the tree trunk surface evolves below 60 °C (see Fig. 4b)). The fire extinguishing system will operate for approximately 260 s. After the fire front has passed off the tree, its re-establishment will no longer cause problems as the temperatures obtained on the surface of the tree trunk are significantly below 60 °C.

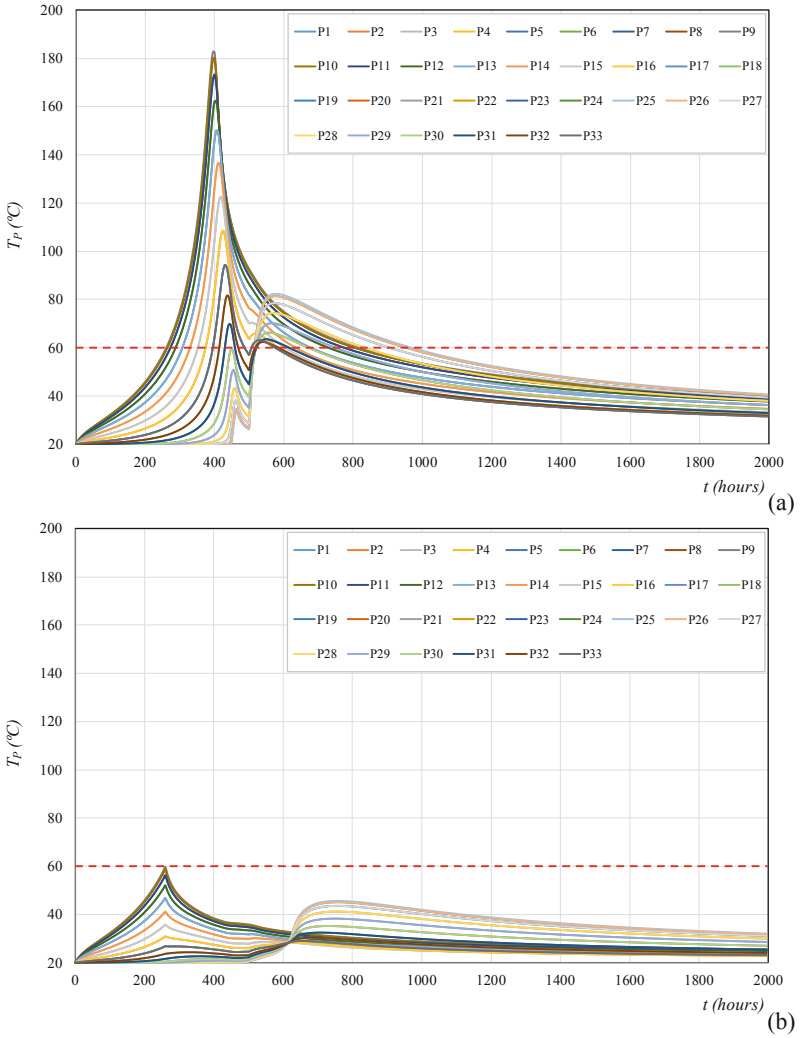


Fig. 4. Evolution of the field temperature distribution in the surface of the tree trunk: a) without; and b) with the use of the extinguished fire system. The red dashed line represents the lethal threshold ($T_P \leq 60$ °C).

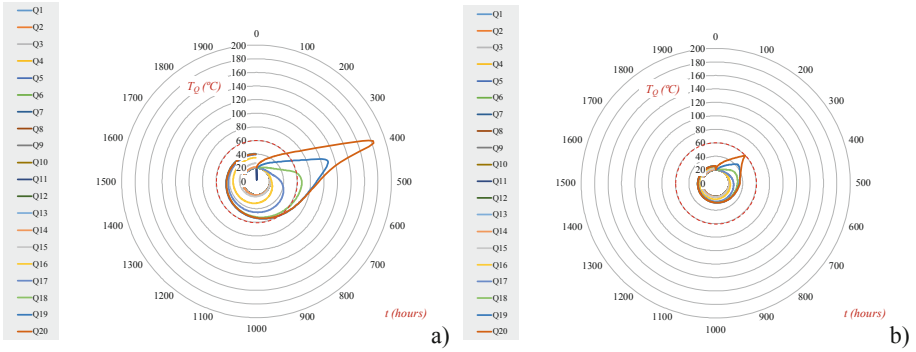


Fig. 5. Evolution of the temperature distribution in the points Q1–Q20 located on the tree trunk radius containing P9: a) without; and b) with the use of the extinguished fire system. The red dashed line represents the lethal threshold ($T_Q \leq 60$ °C).

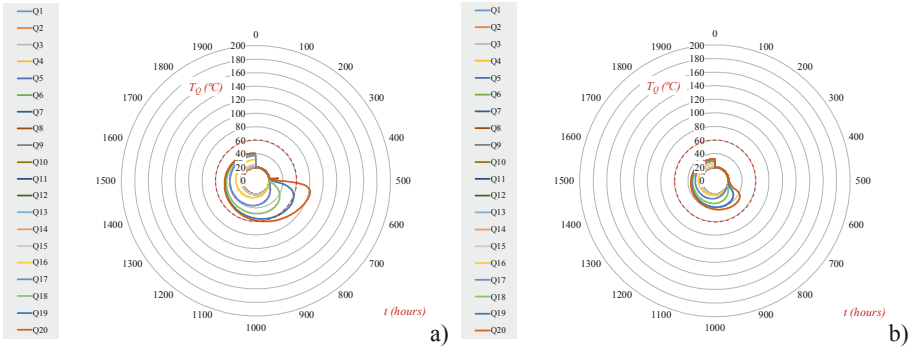


Fig. 6. Evolution of the temperature distribution in the points Q1-Q20 located on the tree trunk radius containing P25: a) without; and b) with the use of the extinguished fire system. The red dashed line represents the lethal threshold ($T_Q \leq 60$ °C).

Regarding to the thermal behavior inside the tree (Fig. 5 and Fig. 6), it is verified that, when the fire extinguishing system is deactivated, on the upstream side of the tree, points located up to the second outermost ring will reach temperatures above 60 °C; on the downstream side of the tree, only points located in the outermost ring will reach this temperature. In the upstream side, the highest temperature (182.6 °C) is obtained at point Q20 (coincident with P9), while in the downstream side the highest temperature (82.4 °C) is obtained at point Q20 (coincident with P25). With the operation of the fire extinguishing system, all temperatures inside the tree trunk are below 60 °C.

5 Conclusions

In this article, the results of a numerical simulation on the action of a fire extinguishing system installed in a tree were presented when a forest fire approached. As a reference, the situation in which the fire extinguishing system is not used was analyzed.

The main conclusions obtained are as follows:

- When the fire extinguishing system is not used the entire outer surface as well as points up to the two outermost rings of the tree will reach temperatures above 60 ºC causing the death of its tissues;
- With the operation of the fire extinguishing system, all points located in the tree will have temperatures below 60 ºC;
- The fire extinguishing system works as soon as the first point located on the tree reaches 60 °C and for as long as necessary to keep all other points below that value.

Acknowledgments. The authors would like to acknowledge the support of the project reference PCIF/MPG/0108/2017, funded by the Portuguese Foundation of Science and Technology (FCT).

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T. Ahram and R. Taiar (Eds.): IHIET 2021, LNNS 319, pp. 1311–1316, 2022.
https://doi.org/10.1007/978-3-030-85540-6

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