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Redha Taiar
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Human Interaction, Emerging Technologies and Future Applications II

Proceedings of the 2nd International Conference on Human Interaction and Emerging Technologies: Future Applications (IHIET – AI 2020), April 23–25, 2020, Lausanne, Switzerland

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Preface

This book, entitled *Human Interaction and Emerging Technologies II: Future Applications*, 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. Indeed, 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. This interdisciplinary book will also expand the boundaries of the current state-of-the-art by investigating the pervasive complexity that underlies the most profound problems facing contemporary society today. Emerging technologies included in this book cover a variety of technologies such as educational technology, information technology, nanotechnology, biotechnology, cognitive science, robotics, and artificial intelligence.

The book, which gathers selected papers presented at the 2nd International Conference on Human Interaction and Emerging Technologies: Future Applications (IHIET—AI 2020), April 23–25, 2020, Lausanne, Switzerland, focuses on advancing the theory and applications for human interaction requirements as part of an overall system development life cycle, by adopting a human-centered design approach that utilizes and expands on the current knowledge of user-centered design and systems engineering supported by cognitive software and engineering, data analytics, simulation and modeling, and next generation visualizations. This book also presents many innovative studies with a particular emphasis on the development of technology throughout the life cycle development process, including 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 nine sections, including

Section 1 Human-centered Design
Section 2 Artificial Intelligence and Computing
Section 3 Human–computer Interaction
Section 4 Augmented, Virtual, and Mixed Reality Simulation
Section 5 Applications in Sport and Medicine
Section 6 Healthcare and Medical Applications
Section 7 Human Technology and Future of Work
Section 8 Management, Training, and Business Applications

We would like to extend our sincere thanks to the Centre Hospitalier Universitaire Vaudois (CHUV) in Lausanne, Switzerland, for their collaboration and kind support. 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.

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 design and applications of a variety of products, services, and systems for their safe, effective, and pleasurable use by people around the world.

April 2020

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Designing Presence

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Abstract. Experience design and engagement is evolving to become the design of presence with the supporting practices and tools of SenseMapping, CC-Align, Experience Vision and Scenario-Based Design Methods.

Keywords: CC-Align · Context · Design · Engagement · Experience · Experience design · Fully-human-compatible · Interaction · Mutual benefit · Presence · Presence design · Relevance · SenseMapping

1 Introduction

Experience design and engagement is evolving to be the design of presence. Presence is sensing the state of being in a specific space. Designing Presence is about connecting physical and mental states – creating sense, sensibility and coherence. Presence is relevance. Presence is bringing identity into context. Design of presence includes listening and leading by including the design of the organization and bringing about mutual benefit for the stakeholders it chooses to serve [1].

Designing Presence transcends and includes experience design and stakeholder engagement. Designing Presence as a practice is embodied in SenseMapping [2] (Fig. 1).

Fig. 1. Visual layout example of SenseMapping; one format.

SenseMapping provides a perspective to design products, systems and services that are fully human compatible; that strongly and openly – and subtly and suggestively – project presence. SenseMapping allows for the design of presence by considering and connecting all five human senses (seeing, hearing, feeling, tasting, smelling) to human sensemaking (head, heart and gut - along with interests and values).

Designing Presence is supported by CC-Align research that discovers the connective tissue between the values and interests of customers and companies – and by

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UserStrategic Experience (USE) and the Experience Vision design methodology that link design processes and customer experiences to business objectives.

2 User Strategic Experience (USE)

Design of Presence is positively correlated with the USE Model: User Strategic Experience [3], where the wants and needs of customers and stakeholders interlace with the business model and objectives of the business or organization. It is also positively correlated with Experience Vision providing a strong framework for experience design that supports business objectives, including the Scenario Based Design Method (SBDM) [4] (Fig. 2).

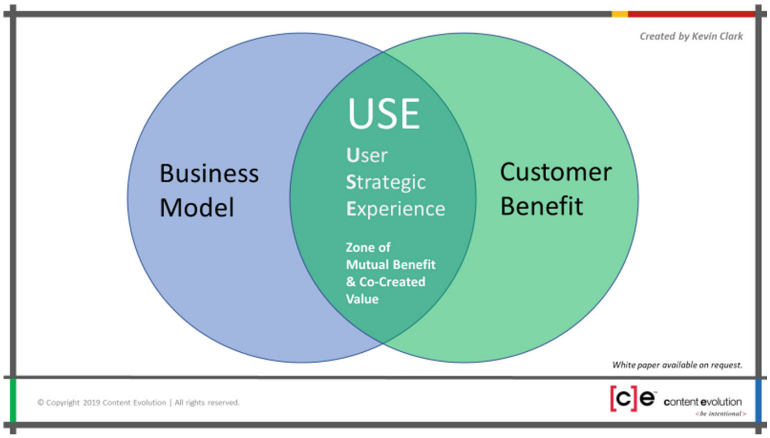

Fig. 2. USE: User Strategic Experience model for co-creating value.

The ability to describe internal and external alignment is critical for designing presence. The CC-Align [5].

Method developed by Choice*flows* which is a contraction of the term "company-customer alignment", is a way to benchmark current state of internal and external interests and values calibration. CC-Align then finds undiscovered opportunities for design and strategic interaction that is beneficial to the organization and those it serves. When repeated, it is a measurement for understanding and documenting improvement.

Evolutionary use cases include "sense-layering" for the IBM Merlin Center for next generation banking experiences [6] reimagining the global portfolio of 400 IBM Client Briefing Centers [7], and the emergence of multi-tract journey mapping first delivered at Toyota [8] and today in use by many Content Evolution and SenseMapping practice clients around the world.

3 The Merlin Center

The Merlin Center as described in a keynote article in CMO Magazine is a place designed to showcase retail banking in the future. Located in Stamford, Connecticut, the Merlin Center concept was created by the John Ryan Group to showcase architectural design possibilities for customer interaction, and IBM provided ideas and technologies to the table (Fig. 3).

Fig. 3. Visual excerpts from CMO Magazine article "Experience Preferred," 2005.

Located in a nondescript warehouse location, the exterior of the Merlin Center gives no clue to what's inside. IBM corporate strategic design is brought in to make the center an over-the-top memorable experience. The inside is already visually competent.

In fact, there is a piece of magic early in a visit that is worthy of the Disney Imagineers. When you start your briefing, you sit in a well-appointed executive conference room. You sit and listen to an overview of the banking industry, strategic trends – all being projected on a screen in the front of the room, animated with the obligatory PowerPoint charts.

Then, about 10 min into the briefing, the presenter says – "yet it would be better to see these trends come to life, wouldn't it?" …and with that a button is pushed on the lectern and what appeared to be a solid wall disappears into the ceiling – revealing a street scene complete with asphalt and streetlights – and across that street the bank of the future mocked up inside the warehouse. For people being briefed it has the desired "wow" effect and sets the stage for opening minds and hearts to what is possible.

So far, so good. The space looks great. There is a lot of tech you can see demonstrated, yet you can't touch it yourself. The space doesn't sound like anything, smell or taste like anything to support the core messages being delivered. IBM design is about to change that to amp-up that WOW.

We called what we did "SenseLayering" for the space. Adding layers of intentional sensory stimulus to the Merlin Center to make it more experiential and to increase the sense of flow where time disappears in purposeful engagement [9]. This is the genesis of the SenseMapping practice that would emerge almost a decade later and after the publication of my book Brandscendence: Three Essential Elements of Enduring Brands where all five human senses are discussed as core contributors to a fully engaging brand.

Rewind. Let's walk into the Merlin Center from start after performing strategic SenseLayering augmented design. Now when you enter, in addition to seeing a competent and inviting space as a start transition from the warehouse exterior, you also

smell coffee and fresh cookies baking. An air oven near the entrance provides the welcoming aroma of baking – and the coffee area is moved from a back space to the front of the house.

We studied spas and found ways to redesign the washrooms to be more than functional. Flowers, lounge furniture, cloth wash towels, spring water dispensers – and an injected background scent of forest highlands during spring foliage development – earthy fresh with a dash of vanilla.

The bank of the future became more sensory competent. It was infused with fresh flowers and interior plantings at the entrance – and injected with a light yet bright citrus to awaken the senses. You could now touch a lot more of the exhibits in the center and use them yourself hands-on without a demonstrator.

The bank of the future also starts to sound like something. It is given life with street sounds when the wall disappears – and quiet sounds of clients in conversations with bankers and background sounds of machines in use, such as printers and copiers – keyboards clicking as phantom people type. The main greeting area now has light jazz playing softly in the background and the washrooms light classical.

It was as we say today about the SenseMapping process, a more "fully human" space in every sense. The new design of the Merlin Center invited people to be awakened, in a state of flow, and fully engaged and present. After the Merlin Center experience "Discovering your WOW!" is the name of a book of design inspirations I wrote with Ron Smith for internal use at IBM to guide the next generation of experiences for clients visiting the company's portfolio of 400 Executive Briefing Centers around the world.

4 Toyota and Multi-track Journey Mapping

After working on the Merlin Center and global IBM Briefing Centers – and doing strategic work on the experience of strategic outsourcing clients – I graduate from IBM 30 years of service. I joined IBM early in life, so too early to simply accept retirement as a permanent state. In the next decade I start several companies, including Content Evolution and Choice*flows* (Fig. 4).

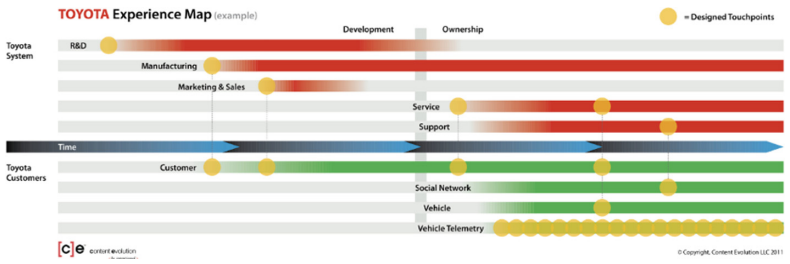

Fig. 4. Toyota multi-track journey map; connecting Toyota with its customers.

In the early days of Content Evolution, we provide our first multi-track journey map, pictured above. It is a first by showing connections both to the journey being taken by customers – and the journey being taken by key constituencies inside Toyota – and the connective tissue between inside and outside the business.

This is also a building block for SenseMaping that would manifest almost a decade later. SenseMapping is the process of and the toolkit for Designing Presence.

5 CC-Align

Customer-Company Alignment, or CC-Align, is a practice of Choice*flows*, a Content Evolution member company. CC-Align provides a research methodology that discovers the values and interests – and intersections – of customers and the companies that serve them. CC-Align has roots going back to the 1980s with experiments performed by Dr. Jordan Louviere, COO of Choice*flows* and one of the most cited researchers in the world with a Google Scholar h-index of 102 (placing him in the top 1% of all published researchers in the world) [10].

As graphically suggested in the Toyota model above, when company and customer activities are aligned for relevance, context and mutual benefit as described in Brandscendence [11] in detail – there is more intention in interaction and positive outcomes. CC-Align finds the connections, and the disconnects. In fact, the results of a CC-Align experiment deliver a grey-scale of fully aligned interactions to completely mis-aligned relationships.

CC-Align is a specific version of a choice experiment to investigate and discern these alignments and draws heavily on the Best-Worst Scaling methodology (BWS, also known as "CC-Diff" in the market research profession), invented by Dr. Louviere.

In one case CC-Align is used to determine alignment between sales representatives of a company and the customers they work with regularly. The CC-Align study determines the motivations and incentives are not creating a shared values and interest environment. By using the results of the CC-Align study and making changes in sales incentives and offers to customers, the business moves from number four to number two in the market – and is then acquired by the number one company in the category, greatly rewarding shareholders. This is a multi-dimensional research that supports presence design.

6 Experience Vision

The "Experience Vision: Vision Centered Design Method" is a comprehensive method which makes it possible to propose new and innovative products, systems and services that are currently unavailable, as well as proposing advances for those that currently exist [12]. It encompasses the entire HCD (Human Centered Design) process and presents a new vision with experiential value for both user and business from an HCD viewpoint (Fig. 5).

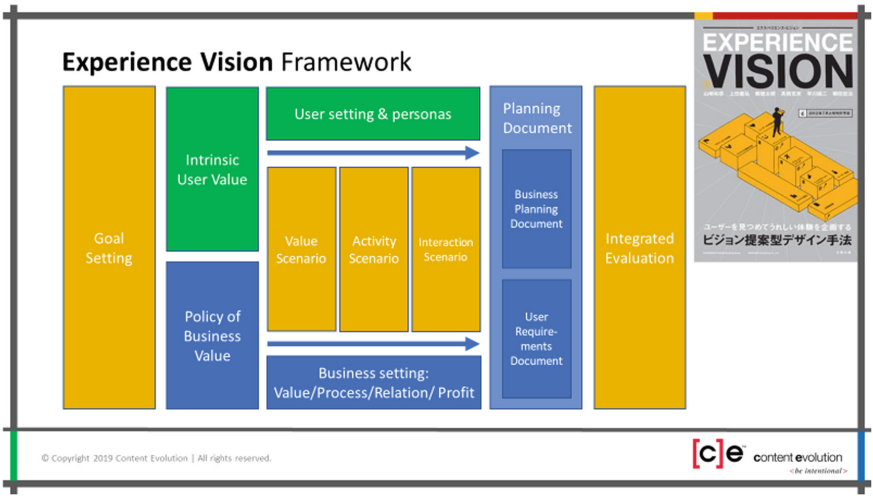

Fig. 5. Experience Vision framework adapted from the book Experience Vision.

The Experience Vision process includes eight formats developed as a practical design tools. They include Goal setting of the project, Intrinsic user value, Policy of business value, Persona, Value scenario, Activity scenario, Interaction scenario and Experience vision (summary). Case studies showed effectiveness and usefulness of the formats as a design tool for this method.

7 Design of Presence

Designing Presence using the SenseMapping methodology reveals the previously invisible fusion of physical world design including products, systems and services – user interaction and experience – and intentional connections with personal and shared values. SenseMapping coupled with Experience Vision and CC-Align create a Presence Design process for discovering, planning and making fully-human-compatible marketplace offerings.

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Hume's Guillotine in Designing Ethically Intelligent Technologies

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Abstract. Intelligent machines can follow ethical rules in their behaviour. However, it is less clear whether intelligent systems can also create new ethical principles. The former position can be called weak ethical AI and the latter strong ethical AI. Hume's guillotine which claims that one cannot derive values from facts appears to be a fundamental obstacle to strong ethical AI. The analysis of human ethical information processes provides clarity to the possibility of strong ethical AI. Human ethical information processing begins with positive of negative emotions associated to situations. Situations can be seen as consequences of actions and for this reason people can define rules about acceptability of typical actions. Finally, socio-ethical discourse create general ethical rules. Intelligent systems can provide important support in ethical process and thus the difference between weak and strong ethical AI is polar.

Keywords: Interaction design · Intelligent systems · Ethical design · Hume's guillotine

1 Introduction

Once again, humankind is on the cusp of a new technology revolution. It has encountered such situations many times in its history. Technologies, work processes, and societies have changed numerous times. Stone tools, fire, sailing, navigation, cannons, printing, clocks, steam engines, electricity, and nuclear energy provide good examples of technological revolutions leading to new forms of work and social organisation [1]. The ongoing revolution is based on intelligent technologies. They are characterised by their capacity to carry out tasks, which have previously required the intelligent information processing of the human mind.

The improved speed of computing and the fast growth of data have made it possible to design technical artefacts with the capacity to do tasks, which thus far only people have been able to carry out. Modern examples of emerging intelligent technologies are not few. Artificial intelligence has penetrated numerous aspects of modern life. Industrial robots, office automation, intelligent medicine, changes in teaching, autonomous traffic systems, and intelligent finance give us a fast vision of the future [2, 3].

In addition to fast routine processing of logical inferences, machines can make decisions between alternative courses of action. They can even learn to make classifications of their own so that people are not able to predict the information states which

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intelligent systems can generate. Consequently, intelligent systems can select between different sense-making courses of actions.

The capacity for selective information processing makes it possible for modern AI-based systems to compare the values of different information states on sense-making grounds. A chess-playing computer for example, can find the best sequences of moves among millions of legal alternatives. Intelligent choices make a machine's actions intelligent.

A very specific view is opened by ethics with respect to thinking intelligent choices. Some information states are more ethical than others, and thus it makes sense to discuss ethics in the context of acting intelligent machines. They can select some courses of action as they are more ethical with respect to certain ethical principles. Thus, intelligent technologies can make operational decisions on ethical grounds. They can choose between different courses of actions on the grounds of implemented ethical principles. For example, intelligent systems can prefer children to middle-aged people in making decisions about the order of medical operations. Such decisions are ethical and carried out by intelligent machines.

For the reasons given, one can speak of ethics typical to using intelligent technologies in two senses. One can speak of the ethical use of technical artefacts in society, but one can also develop systems with ethical capacities of some type. In this paper, focus is in the latter.

2 Hume's Guillotine

A crucial question in considering future intelligent sociotechnical society is how machines can be ethical at all. They are just systems with different electric states which people map as information about reality. The electric states are mapped to factual information. In digital systems power is either higher or lower, and this makes it possible to have two states. These states can stand for truth or false. Thus, information in intelligent machines is apparently factual. Intelligent machines process facts.

Facts are different from values. While facts are binary and can be true or false, values are not dichotomous. Something can be obliged, forbidden, or allowed. The problem of relations to binary facts in binary machines and multiple state values is important in designing ethical information systems and is conceptually important in designing ethically intelligent technologies.

One important problem in relations to facts and values was seen over 250 years ago. Hume [4] wrote: "It is impossible that the distinction between moral good and evil can be made by reason". This aporia is called Hume's guillotine or "is-ought to" problem, which is central to modern ethics. Hume's guillotine claims that one cannot derive from how things are how they should be. When designing ethically intelligent machines, Hume's guillotine is a relevant conceptual problem. One can justly ask whether machines processing facts can have anything to do with ethics at all, and if they do, how is it possible?

Intelligent machines can be ethical in more than one sense. The first position is that people implement their values in the evaluative structures of ethical programmes as traditional chess machines have their human implemented heuristics. This latter

position can respectively be termed *weak ethical AI (WEAI).* The position that machines are able to generate new ethical rules and principles themselves can be called *strong ethical AI or intelligence (SEAI).* In the context of the former position, Hume's guillotine is apparently easier to solve than in the latter. However, firstly, it is important to ask how ethical information processing is possible for people and how weak and strong ethical AI differ from each other.

3 Ethical Process

Hume's guillotine is still an important ethical dilemma today, and one cannot say that it has been solved. To gain clarity on this issue, one must think how it is possible for people to process ethical information. The idea that human information processing can be used to develop intelligent technologies has been called cognitive mimetic [5]. Here, the analysis of human ethical information processing can be used as a model for respective machine information processing.

Ethics are possible as they are real. There are no grounds to doubt that people are capable of creating ethical rules and norms. The process of creating ethical rules and norms can be called an *ethical process* or *ethical information process*, which is an example of human creative thinking. Ethical machines are machines which can participate in an ethical process.

Human experience, i.e. conscious mental representation, forms a central component of human information processing and thinking. The information contents of experiences and representations can be called mental contents. Mental representations have their cognitive and emotional dimensions. Both have an important role in ethical information processing, but Hume's guillotine cuts them apart.

Ethically, an important type of mental content is emotional valence [6]. Most emotions can be divided into positive or negative, pleasant or unpleasant, and happy or sad. Therefore, all situations emerging in the course of actions can be experienced positively or negatively.

Emotionally grounded ethical thinking is normally labelled as emotivism [7]. These theories begin with the idea that situations of life and respective experiences are emotionally positive or negative (pleasant and unpleasant). The emotional analysis of consequences of actions thus provides the basis for the ethical analysis of actions and action types. For example, the so-called golden rule (one should not treat others in ways that one would not like to be treated oneself) can be seen as a generalisation of situational experiences of deeds in which the principle is followed or violated. Thus, the emotional and ethical information process is in the analysis and experience of the emotional valence and can be taken as the first point of the ethical process.

Consequently, the development of ethical norms is grounded in the analysis of emotional situations. However, it is not wise to end the analysis of the ethical process with emotions. The situations of life are consequences of actions. Thus, the value of actions can be defined on the grounds of the valence of the situations arising as a consequence of particular types of actions. Norms describe what kinds of actions have had emotionally positive or emotionally negative consequences. Actions leading to pain are not acceptable and actions leading to positive emotions are good.

The first step in defining ethical principles is to classify situations emotionally and actions leading to situations of two types respectively good or bad. Thus, one can generate ethical norm "avoid excessive use of alcohol as it leads to social and health problems". Alcoholism is a situation in life and drinking is the action which ends to this situation.

However, different people experience situations in different ways. Social interaction can be painful for some while it is positive for another. Therefore, the general ethical norms can be seen to be consequence of informal (everyday) and formal (or political) discourses. This socio-ethical process has been investigated in discourse ethics % [8]. Thus, it is essential to add to the ethical process the discourse between people in society related to political analysis and even laws.

Hume missed that the ethical process and each norm in the generation process has three components. Firstly, there is an emotional analysis of situations in life. People do this kind of analysis every moment of their life. Secondly, the ethical process includes factual analysis of actions leading to the given types of situations. Finally, one needs to add a socio-ethical discourse, which defines the social and historical properties of a situation. Though Hume understood clearly the triad of emotions, reason, and action, his guillotine unreasonably broke the process.

Hume's guillotine is a consequence of a mistaken analysis of the ethical process and ethicality of actions. Hume does not pay attention to the fact that ethics arise from the simultaneous analysis of situations. Cognitive and emotional aspects of situations are encoded in a parallel manner. This is why, the very question whether (cognitive) facts be used to define (emotional) values is senseless. Facts and values are two sides of one and the same mental event. Social discourse works to get a generalised idea about the relations of actions, cognitions, and emotions. Accurate analysis of the ethical process makes it possible to study the problems of weak and strong AI from a new perspective.

4 Weak and Strong Ethical AI

The analysis of the ethical process aids us in considering the relations of weak and strong ethical AI. Following the founding ideas of life-based design giving clarity to the way ethics and ethical norms are created in human life enables researchers to study the generation's ethical design requirements and the ethical information processing for technologies. Searching for answers to two questions is central. Firstly what kinds of technologies should be developed, and secondly, how can these technologies be taken part of everyday life [9].

Weak AI is not a difficult case. Ethical norms can be implemented in AI programmes. It is possible to define the situation and their factual properties. This information can be recognised by intelligent systems in data, and associate ethical norms can be followed in actions. Thus, designers can build recognition association type action models with ethical contents. For example, if some situation is known to cause pain, technology should act to avoid such situations.

However, strong AI is more challenging, and there are no clear-cut solutions to the problems of designing strong ethical AI. Actually, the border between weak and strong

AI is not absolute, but systems can differ in their strength. The criterion for the strength of an ethical AI (EAI) system is the capacity to create new ethical norms without human involvement. Firstly, it is possible by means of data analysis to study possible pain or negative valence causing situations. For example, data mining can find factors causing illnesses, which have been unknown so far. Such research has existed for a long time. For example, Durkheim [10] found a link between religions, social discourse, and suicides, and a connection between smoking and lung cancer was found in the sixties. There is no logical obstacle to finding such associations by means of intelligent systems. Thus, human-supported AI and data mining can be used to find novel factual grounds for new ways of behaving. This kind of EAI is machine-supported AI.

Another possibility is to ask machines to recognise features, which are known to cause emotionally negative experiences. It is also possible to register human responses to different types of situations to classify them as emotionally negative. AI programmes can actively search for new combinations so that the human component is one-step further from the previous case. The information found can be associated with the actions ending in negative situations, and thus new information can be used to create new ethical rules.

Finally, the core issue is whether intelligent systems can create new previously unknown ethical norms without human involvement to process on the grounds of their factual data. Machines can analyse by different means emotional valences typical to some situations. They can also associate the results of emotional analysis to the actions. They can even analyse general social attitudes in these situations. The autonomy of ethical systems can thus be gradually increased. But human involvement can be relatively direct in creating new ethical rules.

5 Final Discussion

Since information systems are involved in carrying out increasingly complicated actions. It is essential to develop ethical capacities for these systems. Their operational roles can be very independent, and thus it is essential that they can follow sense-making ethical practices.

Apparently, Hume's guillotine can make it hard to develop ethical autonomy for future systems. Intelligent systems are in the first place factual information processing devices, and it is not easy to see how one could derive values from facts. Despite conceptual difficulties, it is important to think how intelligent systems can follow ethical norms in their actions.

Our analysis suggests that there seems to be two poles in ethical information processing, which can be called weak and strong ethical AI. The first kind of system can apply given ethical rules in given situations. They can recognise critical features in situations and choose their actions on the ground. In such cases, ethics are just a human implanted feature in a recognition action system. This kind of ethical processor can be called weak AI.

Nevertheless, despite Hume's guillotine, people are able to create ethical thoughts and information processes. Thus, it must be possible to create machine-supported

ethical processes with greater autonomy. The analysis of the ethical process also provides clues about how machines can be added to improve and create existing ethical processes. Thus, the second pole in the strength of ethical AI is formed by systems which can collect data, associate it with situations, and link the situations to emotional valence and respective actions. Finally, such systems could develop new ethical principles to follow. This kind of ethical AI can be called strong. Thus, developing strong ethical AI is a gradual process, and there are no absolute limits between its weaker and stronger forms.

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Symbols and Functions in Human Machine Interface: Are Google Icons a Possible Solution for Intercultural Usability?

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Abstract. We explored the possibility of taking icons from Android Smartphones, for the use in graphical user interfaces (GUI) in bakery sheeter. This idea was generated from the fact that Android Smartphones are sold worldwide and that the icons used in the menu should have a degree of popularity that most people could deal with. With this research question in mind we created a mixed method design for the study (qualitative and quantitative data). Results show that some icons were able to represent basic navigation function in industrial machines.

Keywords: Graphical user interface · Usability · Icons · Intercultural

1 Introduction

User Interfaces in general have to be self-explained and easy to use. Norms help to reach this goal. The ISO 9241 is a multi-part standard from the International Organization for Standardization [1] covering ergonomics of human-computer interaction. In some areas, those norms lack intercultural perspective, which is a challenge in general [2]. Many industries, like for example the bakery industry, machines are sold in many different countries. These machines are used by people of different cultures and technical- and educational-background. These circumstances lead to the following study: We explored the possibility of using icons from Android Smartphones in a graphical user interfaces (GUI) of a dough sheeter. This idea came as a conclusion from the fact that Android Smartphones are sold worldwide. With a market share of over 86% the Android operating system is dominating the smartphone market in 2018 [3]. Simultaneously over 383 million smartphones were sold in Q1 of 2018 [4]. This means that nearly 330 million Android phones in Q1 of 2018 were purchased in areas all over the world. With this fact, a lot of "the same" icon/function process knowledge is distributed to different kinds of cultures of the world. Those icons used in the Android smartphone would have a degree of recognisability that deserves attention. Because of this and the fact that differences in GUI Design alters learning of new GUI functions [5] we assume that Google icons could be used in the navigation of an interface in an industrial context, because of possible implicit knowledge of the participants.

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2 Methods

17 subjects (10 female; mean age, 24.35; range 20–28) were recruited from the student body of the School of Applied Psychology at the University of Applied Sciences Northwestern Switzerland and participated in a mixed method study (integration of qualitative and quantitative data). The Participants were assigned to one of four groups. Those groups would start with either the original dough sheeter or Google Icons; and assign either icons for navigation or icons for dough processing.

All Participants filled in an online questionnaire measuring technology acceptance and technical expertise, two subscales of the questionnaire for Technology Affinity (TA-EG), as well as gathering demographics.

To asses, whether Google icons represent a valid alternative when designing an industrial user interface, participants were instructed to assign cutouts of either the original dough sheeter icons or Google icons to laid out cards with descriptions of existing functions of the sheeter. Since there were a total of 53 function-icon pairings in the user interface of the dough sheeter, it was not feasible to have all participants assign all of them. They were instead split into two groups that consisted of "dough processing" or "navigational" pairs. The functions-icon pairings and descriptions were provided by the manufacturer of the dough sheeter. 33 Google icons were selected by experts from the catalogue for material design with the criterion to find all potentially suitable items (out of 955) while not cluttering the list with possibly hundreds of unrelated icons. After these steps, participants would assign icons to either 27 dough processing or 28 navigational function descriptions. Participants who assigned to dough processing functions first saw a video introduction into how dough sheeters work and were taught some of the most important bakery jargon (as per a pre-test) to understand what the functions described. While assigning, participants were thinking-out-loud which in turn was summarized and noted on a per-function and per-icon level by a researcher in the room. The assignment was completely free. Participants could take their time, make (and comment) changes and decide whether one, multiple or none of the icons fit any given function. They were also expressively told that they did not have to assign all icons or cover all functions.

3 Results

Statistical Analysis showed both navigational and functional assignment groups were comparable in terms of technology acceptance and technological expertise. The results of the technology acceptance scale were not normally distributed (Kolmogorov-Smirnov: .011). Though the results of the technological expertise scale were (Kolmogorov-Smirnov: .200). Thus a Mann-Whitney U-Test was performed of the former ($U = 42.5$, $p = .475$) and a t-test for the latter ($t(15) = -.997$, $p = .136$).

As assumed the icon-to-function assignment was higher in the industrial icons since they may have been more suited to dough processing. Surprisingly over 20% of the Google icons also showed a high degree of icon-to-function assignment. In Fig. 1 all assignments for every Google icon and every function are presented.

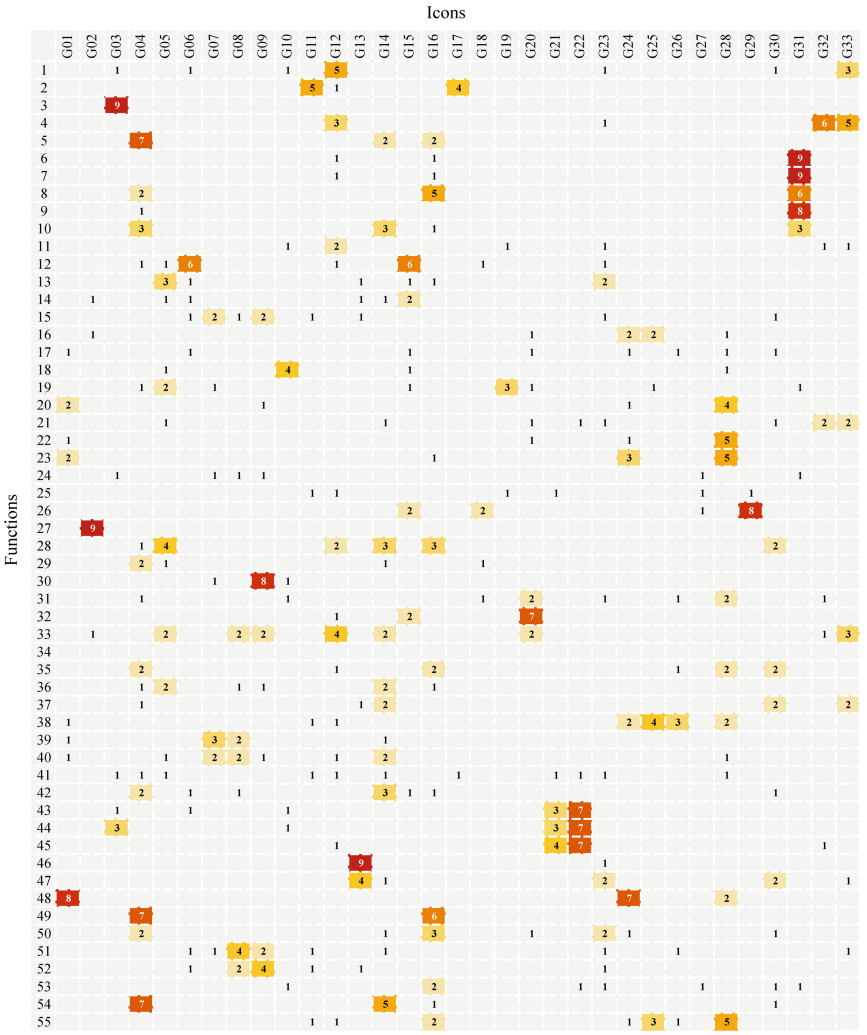

Fig. 1. This shows a figure consisting of how often (numbers in black or white) a Google icon (upper axis) fitted into a navigation function (left side) of an industrial dough-sheeter. The darkness indicates the number of assignments of an icon to a given function.

The information in Fig. 1 is only able to show how icons are being interpreted and how the icons were interpreted as best fitting to a certain function. Without verbal information from the participant, at this stage, no conclusion about the quality can be presented. This means that e.g. the allocations of the icons G14, G28, G16, G31 and G04 could be due to their generic appearance or due to their multi-facetted effect on the viewer's opinion. To find a stable ground for further interpretations, qualitative analyses of the thinking-out-loud summaries was performed to shed light on what the strengths and weaknesses of the presented icons are. For the first twelve icons this is shown in Fig. 2.

N°	Symbol	Assign-ments	Assign-ments / functions	Strengths	Weaknesses
G01		17	2.13	Known as refresh from internet browsers	
G02		12	3.00	Is recognized as trashcan / recycle bin	
G03		16	2.67	Is recognized as a Home button to return to the starting page	
G04		42	2.47	Is recognized as a symbol for settings	Assigned a lot since it is unspecific / generic
G05		20	1.67	Is recognized as a pen to edit something.	
G06		15	1.50	Is recognized as a plus to add, increase or speed up	
G07		12	1.71	Left pointing arrow is assigned to reduce or go back	Interpretation is dependent of rotation / pointing direction
G08		16	1.78	Is used for slowing down and interpreted as less-than	Interpretation is dependent of rotation / pointing direction
G09		23	2.56	Is used for next and end functions	Interpretation is dependent of rotation / pointing direction
G10		11	1.38	Tic-mark to choose option or mark as accepted	
G11		12	1.63	Is used to close or shut-down	
G12		29	1.61	Is recognized as a menu or a list (of settings) and was also interpreted as thickness of dough	

Fig. 2. The figure shows the first twelve assigned icons. It is sorted by the internal number of the study, and presents the used Google-icon, absolute assignments to all functions, ratio between allocations and numbers of all functions it was assigned to as well as verbally generated strengths and weaknesses by participants

With the additional qualitative data, the reflection and the decision of which icon to use in industrial setting is much better grounded. 1. If GUI designers are not quite certain about whether to take e.g. G05 or G04 for possible settings and changing process G05 seems to have an advantage over G04, because too many allocations for different functions could be a sign for to many interpretations of what this icon stands for, which was also mentioned in qualitative data. 2. If there are icons that are similarly

looking (e.g. G07 and G08), qualitative data shows that it is to prefer only one of those and in this specific case take that one that is associated intended function by the GUI designer. In case of G07 and G08 it could be “go back” or “less than” because “slow down” or “reduce” points on the same dimension.

4 Discussion

In this study we assumed, that Google icons could be used in the navigation of an interface in an industrial context, because of possible implicit knowledge of the participants due to the massive distribution of the android OS in smartphones [3, 4]. We found evidence that strengthened our assumption. We also found that without qualitative data, this kind of research could lead in the wrong direction. When it comes to the interpretation of the intention of the user. In addition, replications of this study with a sample of subjects with different cultural background will show if we can get closer to a solution that the cultural difference can create when it comes to human machine interaction [2]. In summary the analysis of Google icons was valuable especially regarding the thoughts of the user when it comes to functional assignment. With this knowledge, a more targeted use of icons could be realized during the design of new GUIs in industrial context.

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A Democratic, Green Ocean Management Framework for Environmental, Social and Governance (ESG) Compliance

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Abstract. In a dynamic and ever changing business landscape organizational sustainability is defined and redefined according to the socioeconomic challenges. This paper presents a practical framework that can significantly support organizational efforts on approaching, achieving, sustaining and improving its environmental, social and governance (ESG) strategies, objectives, and targets. The proposed framework, referred to as DESGGO (Democratic ESG Green Ocean) is based on the Company Democracy Model (CDM), covering the ESG governance elements/factors. Furthermore, the paper introduces a synergetic relationship between Corporate Social Responsibility (CSR) and ESG indicating the evolution of an organization to extend from applying outstanding governance practices, which lead to Blue Oceans, into outstanding social and environmental practices which lead to Green Oceans. The paper analyses the main ESG criteria per category and maps them on the DESGGO, six ESG and CSR progression levels moving the organization from Red to Green Oceans by adapting ESG practices.

Keywords: Innovation · Green Ocean · Red ocean · Blue Ocean · Ethics · Sustainability · Governance · Democracy · CSR · Management

1 Introduction

Corporate competitiveness, values, and structures have always been related to the degree of sustainability that can be achieved. Well sustainably positioned organizations can absorb economic, market, financial and political turbulences, maintain operations, recover and return to their progressive and development course. However, under the

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new and current definition of sustainability, organizations are considered sustainable primarily through their environmental actions and ethical impact on society. Such goals shall be achieved with the same ethical dimension in corporate governance with respect to the people and the organizations itself. The three new pillars of organizational sustainability (environmental, social and governance) form the ESG factors, which contributes to better identify the organizational future financial performance in terms of return and risk. Research indicates that companies which adopted social or environmental standards achieved better operational performance and positive effect on the performance of their stock price [1]. ESG has turned out to be today a very important organizational valuation index that impacts significantly the investments in organizations [2]. The sustainable, responsible and impact (SRI) investment assets reached the 12 trillion dollars in 2018 from which the 11.6 trillion (8.1 trillion in 2016) is handled by asset managers that consider the ESG criteria [3].

One of the main strategies towards achieving high scores in the ESG criteria is the degree of sustainable innovation an organization applies on the development of its products, on the delivery of its services and on the governance of its people and operations. The impact of the ESG factors in the established organizations ignites a continuous quest beyond Blue Oceans. To achieve and maintain sustainability, it is required to think and act beyond the opportunities of the Blue Oceans. Organizations targeting high ESG scores aim to the Green Oceans, through sustainable innovations.

2 Corporate Sustainability vs. Corporate Sustainability

The recent waves of environmental activism have inflicted great attention and popularity on the term sustainability. In this context, sustainability is closely tied to environmental concerns. Regardless of those events, the Oxford dictionary describes the word essentially as "the ability to be maintained at a certain rate or level" [4], which allows for a great range of different interpretations and applications, possibly unrelated to tightly environmental matters.

In a corporate context, sustainability used to be considered from the perspective of a firm's operations. Operational Sustainability is concerned with determining the ability of a business to maintain its current practices and establishing proficiency to do the same in the future [5]. Furthermore, it describes the activity of managing the triple-bottom-line, a firm's financial, social and environmental obligations and risks. The underlying financial sustainability element captures essential importance, as a company's historical main purpose is shareholder value. Thus, corporate sustainability out of a firm's perspective used to revolve around balancing a number of factors in order to enable the firm to operate successfully and profitable in the future.

However, with the recent trends thriving towards green thinking amongst individuals and corporations, the term Corporate Sustainability has been coined to a different meaning. Environmental concern is not only expressed through a half-hearted CSR campaign to improve reputation, but companies emerge, stating their sole purpose in helping the environment and omitting partly shareholder value.

The new meaning of Corporate Sustainability describes "the discipline by which companies align decision-making about the allocation of capital, product development,

brand and sourcing with the principles of sustainable development" [6]. Therefore, companies are no longer solely concerned about sustaining their operations management, but sustaining their operations via sustaining the environment.

This shift from operational sustainability towards an environmental sustainability-focus has been occurring at a fast pace, driven by changing customer values and expectations. Today, corporate sustainability measures and initiatives are not only a form of competitive advantage, but they are a necessity for viability and survival. Customers, regulators and investors scrutinize firms regarding their environmental impact. This has led to the emergence of semi-official, but trendy, metrics, such as the ESG Index.

3 ESG Index Structure, Dilemmas, and Contradictions

ESG comprises Environmental, Social and Governance dimensions in indexes and ratings. It specifically consists of a range of objectives on Best Practices for companies aiming to gain social consciousness & ethics in operations, positive environmental impact, and meaningful economic profitability at scale. The investors/board members/employee relationships, as well as company/stakeholders/market relationships, are evaluated and standardized against a best practice. The dimension of Governance refers to the way the power is exercised over the corporate entities. It focuses on the organization's direction and performance, strategy formulation, policy-making and accountability of the board. It is, by extent, framing the emergence, organization and dynamics within the board, as well as board-company and board-shareholders. Indeed, under the ESG standard "a new corporate governance approach" emerges [7]. Each dimension is composed of sub-categories where an in-depth evaluation is being undertaken by rating agencies.

The Environmental dimension has a nature-friendly meaning but can be understood also as business environment from a natural resource standpoint, comprising climate change, nuclear energy, and sustainability. The Social dimension focuses on diversity, equality, human rights, consumer protection, and animal welfare. For instance, ESG rating-organizations have a concern in animal testing for cosmetics & medical products, where alternatives like cell-culture could be used instead. The Governance dimension covers management structure, employee relations, executive compensation, ethics, and employee compensation.

This paper addresses the very crucial issue related to the lack of consensus on the ESG rating methodology. Indeed, even if broad criteria have been expressed, the method of assessing the quality and the completeness of each dimension for a specific company varies from one rating agency to another. MSCI, Sustainalytics, Moody's, and S&P Global are some examples of organizations that rate ESG differently. Therefore, any organization can come up with various ratings, depending on the criticality of each topic covered, and the overall methodology employed, creating serious contradictions on the methodology, the rating and the overall initiative [8]. Nauman affirms in the Financial Times that "this lack of standardization can be confusing for companies, whose ESG scores often do not match up across agencies". Other professionals believe that there will never be a unique ESG rating [9]. This paper attempts

to tackle this issue by proposing a comprehensive rating methodology, as well as operations models and guidelines for companies to score high on the ESG, regardless of who is rating.

4 An ESG – CRS Synergy Towards Green Oceans

Corporate strategies have been increasingly impacted by concerns on Sustainability, materialized by the ESG index. Sustainability is nowadays measured, indexed and benchmarked on various corporate strategies, ultimately aiming to homogenize the value creations standards toward shared-value innovation and long-term profitability.

Since the 1970s, Corporate Social Responsibility (CSR) is a prevalent concept in corporate strategy and development which started as an irrelevant or doubtful idea and got transformed into an indispensable organizational element widely recognized and accepted by business managers and stakeholders [10]. Over time regulators gave CSR a more institutional status linking it with organizational compliance on legal and ethical practices, something similar to what ESG does today. However, the meaning of CSR changed over the time by integrating characteristics towards representing a number of stakeholder rights, responsibilities, obligations, and various forms of philanthropic and charity activities [11]. Now the objective of CSR is to build business sustainable growth in a responsible manner [12]. Despite the growth of CSR, the concept did not seem strong enough to cope with the current global concerns. ESG took over and according to research CSR turned out to be mainly the Governance dimension of ESG [13]. Taking the evolution of the CSR and its integration with the ESG, a strategic synergy can be observed that can drive organizations from Blue Oceans obtained with ethical governance through the Company Democracy Model (CDM), into Green Oceans (Fig. 1).

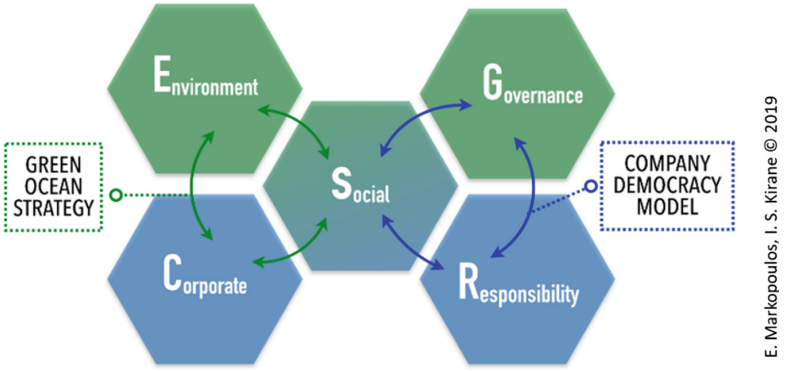

Fig. 1. ESG-CSR synergetic relationship

In this synergy the dimension of 'Corporate' refers to any practice of strategy, management, leadership and operations in an organization. It also comprises the value and cultural dimensions. 'Responsibility' relates to the relationships the company established internally and externally, respectively being managers-employees, managers-board, board-shareholders, and corporates-customers. 'Governance' comprises all practices and processes relative to power exertion, decision-making, interest-conflicts, and ethical strategic management. 'Environment' can be understood as the entire surrounding the business operates, referred as the business environment, or under the ESG meaning, the ensemble of Ecological, Economic, and Earth-friendly perspectives. The 'Social' dimension is the center pivot key of this system where all dimensions of both ESG and CSR can operate. It is the common ground on which companies can build added-value and meaning for long-term profitability and acknowledgment among peers and markets. The Social dimension refers to the employee-managers relationship, the company's legal compliance to social plans and governmental objectives, but mostly to the recognition of the societal-knowledge treasure, which can be democratically benchmarked for corporate innovation.

Value synergies are represented by the circular loops, corresponding to the principle that the whole is greater than the sum of the parts, adjusted to the value creation from ESG-CSR perspective. Value Synergies are profitability, benefits, and output amplification via the intricate relationships of long-term value creation components. This CSR-ESG synergy emphasizes the Green Ocean Strategy achieve by the integration of the Corporate, Environment, and Social dimensions, supported by the Company Democracy Model (CDM) [14], which creates organizations sustainability by integrating the Social, Governance, and Responsibility dimensions under a democratic perspective.

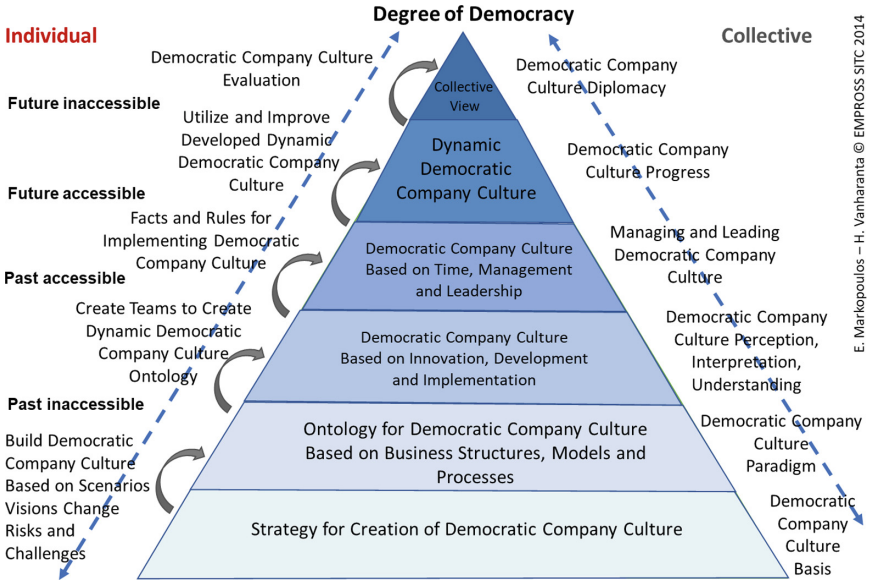

Fig. 2. Co-evolution of the individual and collective dimensions on the developing of a dynamic democratic environment

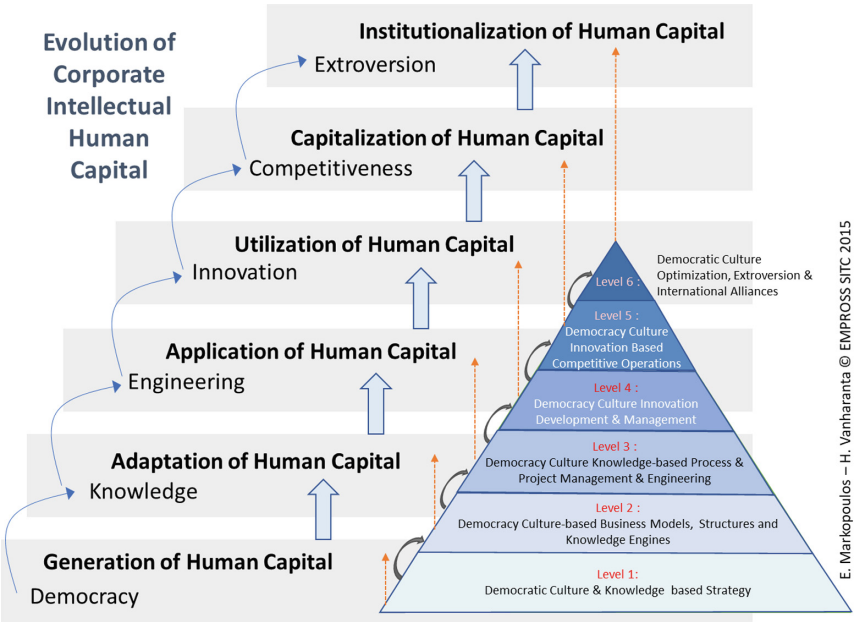

Fig. 3. Knowledge elicitations process incorporate democratic environments and its transformation into human capital.

Several tools are available today for the integration and implementation of the Green Ocean Strategy such as the 3S Wide Innovation Matrix and the Turquoise Canal Strategy Conversion Methods [15], but also for the implementation Company Democracy Model such as the Evolute technology and Fuzzy system applications. The Company Democracy Model synchronizes in a collective way responsible governance (Fig. 2) for knowledge elicitation and transformation into corporate human intellectual capital (Fig. 3) [16]. These are examples of an array of models and protocols proposed for an ESG-CSR Synergistic Innovation.

5 ESG-CSR Score Through Green Ocean Strategy and Company Democracy Model

The Green Ocean Strategy (GOS) and the Company Democracy Models are cornerstones of modern corporate Strategies as they provide Value Amplification via multiple layers of Synergies such as the ESG-CSR and among themselves with the CDM-GOS meta-synergy. Markopoulos and Kirane et al. [15] conceptualized the knowledge evolution for Green Oceans via the Company Democracy Model, providing companies with a framework of internal organizational management guidance for external strategic green alignment (Fig. 4). From the intellectual capital, green fuel production, that can be collected in a democratic culture for social and shared value innovation (level 1), this synergy establishes incremental steps to access Green Oceans (level 6).

The CDM driven Green Ocean Strategy fulfills all the ESG-CSR dimensions and contributes significantly to the company's ESG scorecard. The Environmental dimension is achieved with the green innovations derived from the GOS model which can be highly profitable. The Sustainability dimension can be approached by the GOS model either from the meaning of sustainability for the environment or from the sustainability for the company. Approaching sustainability from the environmental point of view can be considered as GOS innovation. On the other hand, organizational sustainability is achieved from the democratic element of the GOS that derives from the CDM and assures the continuous development of human intellectual capital for organizational innovation and competence. Lastly, the Governance dimension is achieved through the transparency, ethical and democratic organizational culture and governance offered by the democratic base of the CDM in the GOS.

Organizations that can deeply analyze the philosophy of the GOS and execute its operations can achieve significant ESG actions, results and ratings.

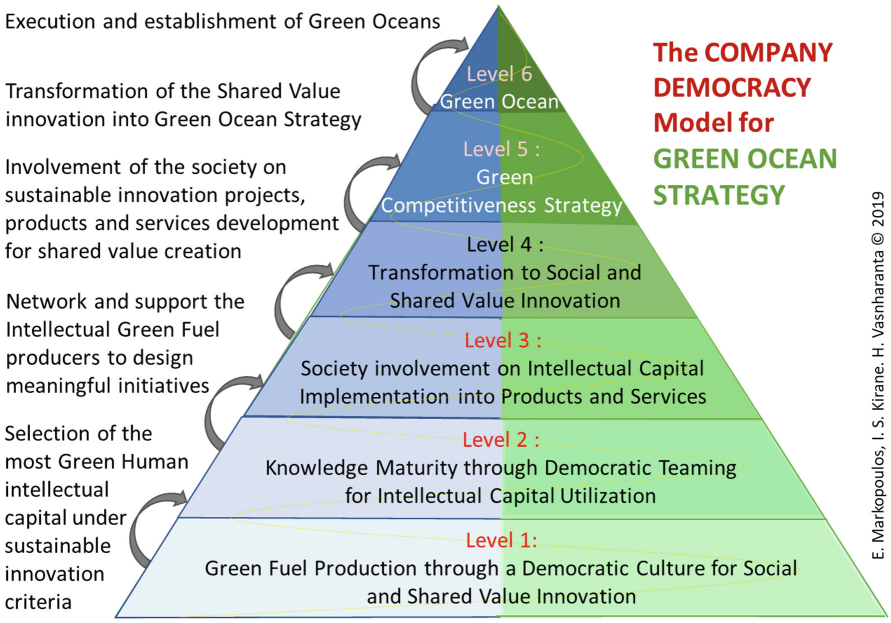

Fig. 4. Knowledge evolution for Green Oceans via the company democracy model.

6 Diagnostic Tool for ESG/CSR Strategic Mapping

The Diagnostic Strategic Mapping from CDM to CSR and from GOS to ESG presents a way for companies to assess, along with their activities, the progression towards the ESG indexes. This mapping separates the Company Democracy Model (blue segment) and the Green Ocean Strategy (green segment), incremented by their respective 6 + 1 levels (Fig. 5). Level 0 named 'Heroic Teams and Ad Hoc Processes', indicates that in

every organization there is the will but not necessarily organized actions. The levels 1–6 of the Company Democracy Model are referred on the classic pyramid representation [14]. The levels 1–6 of the Green Ocean Strategy [15] originate the mapping: from a Conceptually Aware yet practically inactive organization (level 1), to the Implementation of Sustainable Culture Value and Strategies (level 2), for the establishment of business models and structures (level 3), that can lead to New Green Products/Services development (level 4), for Co-opetitive in Innovative Value Chain (level 5) needed to reach Sustainable, Meaningful and Impactful Profitably (Level 6), the ultimate stage where the highest score that can be attained.

The term co-opetition, at level 5, is the antagonistic philosophy of competition, promoting co-operation and collaboration for Sustainable Value Innovation and Amplification, the core of the Green Ocean Strategy.

This mapping covers an array of topics, from the most Governance-focused on the far left to the most Environment-focused on the far right. There is a common ground to the Company Democracy Model and the Green Ocean Strategy in their synergetic value, the Social factor. Social challenges are both central in the CSR/ESG relationship and in CDM/GOS dynamics. Therefore, this category stands on both segments, from the most corporate-focused on the far left to the most community-based on the far right.

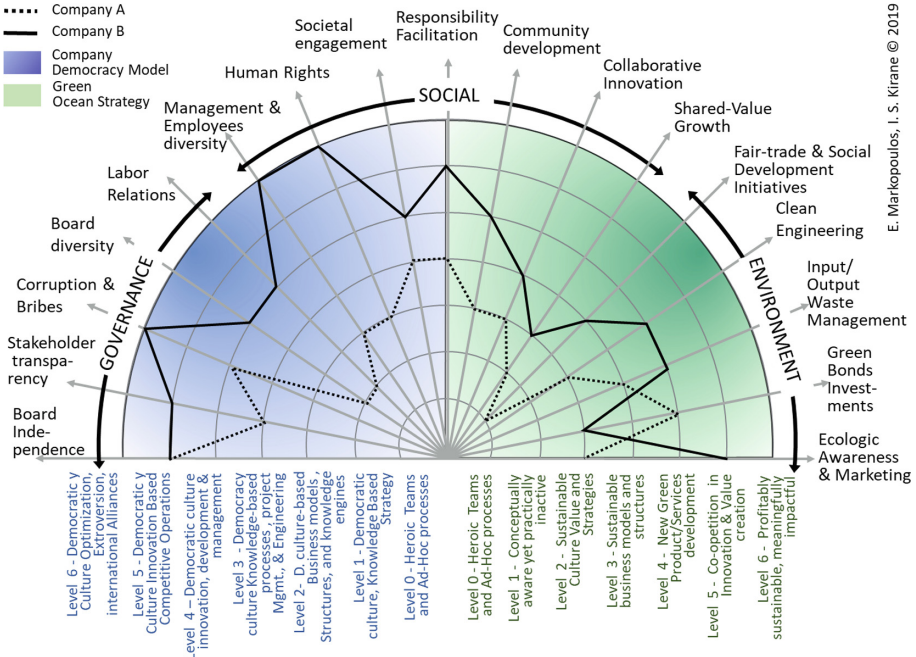

Fig. 5. Diagnostic strategic mapping: CDM to CSR and GOS to ESG

7 Linear Corporate Restructuring in CSR & ESG

Most of the hierarchic multinational traditional companies are already progressing on the CSR by improving their Corporate Governance practices. The Linear CSR Restructuring for ESG high scoring proposes (Fig. 6) is a roadmap for companies aiming to score high on their ESG index, by tacking first their CSR challenges. Points of the ESG index are being progressively checked along with the roadmap as it follows.

In this linear approach, 'Responsibility' in governance covers the Corporate-Political Contributions, Executive Compensation, and Board Independence criteria of the Governance in ESG. By democratizing corporate procedures and processes via the various Company Democracy model versions, a company can both check the Governance and Social dimensions of the ESG Score. The Corporate-Political Contributions, Board Diversity, and Anti-corruption policies are being solved for the Governance dimension; while the Workplace Safety, Labour Relations, Diversity & Bias, and Human Rights are being addressed on the Social dimension. The CSR monitoring & conversion strategies correspond to the Turquoise Canal, an array of conversion strategies by allowing companies to successfully and effectively transition to the Green Ocean Strategy. This includes various models and planning & feedback methodologies such as the 3S Wide Innovation Matrix, or the ESG/CSR Strategic Mapping. Lastly, the integration of the Green Ocean Strategy is necessary for companies to score high on the ESG, as the philosophy itself allows for company to progress on socio-environmental matters: Green Building & Smart Growth, Clean Technology, Decarbonization, Input Preservation, Clean Engineering for the Environmental dimension; and Community development, Collaborative/open innovation, and Workplace benefits on the Social dimension.

Fig. 6. The linear corporate transformation from CSR and ESG scoring

8 The Democratic ESG Green Ocean Model

The symbiosis on the ESG and the CSR practices under the Green Ocean Strategy for Environmental and Sustainable innovation and the Company Democracy Model for ethical and transparent Governance create the Democratic ESG Green Ocean Model (DeESGGOM). The model is visualized with a double pyramid with the internal, blue pyramid, to be the Company Democracy Model, representing the corporate Governance, and the external green pyramid to be the Sustainable and Environmental dimensions achieved from the integrations of the ESG and SCR practices (Fig. 7).

The Green pyramid (Environmental and Sustainability) follows the staged (leveled) concepts of the Company Democracy model and presents 6 levels of incremental development and organizational maturity towards reaching the optimal stage where high ESG scores and ratings can be achieved.

The first level of the model is related to the organizational culture where it identifies the degree of the ESG conceptual awareness and the distance from being practically active. The second level designs and executes an organizational sustainability culture by emphasizing on the added value for the organization from the people within (employees) or outside of it (clients, society). This is the stage where teams are being developed to ignite organizational culture and engage the society. The third level is the actual execution of this new ESG oriented organizational culture by adjusting the organizational business models and structures to reflect the ESG strategic goals. It is the level that the Governance dimension drives this level strongly. The fourth level is the outcome of the strategy execution where the new ESG oriented products and services are being developed. This level acts as the strategy proof of concept. The fifth level drives the co-opetition spirit needed for the organizations not to stay only on the new ESG driven products and services but also to invest and advance them into ESG driven innovation and gain the competitive advantage that can return profitability and sustainability. Lastly, the sixth level measures the sustainable and meaningful impact of the organization on the society and the profitability gained in financial and reputational terms. It must be noted that the Democratic ESG Green Ocean Model is an organizational management model and therefore profitability is related to the organizational sustainability needed to achieve and maintain the environmental sustainability.

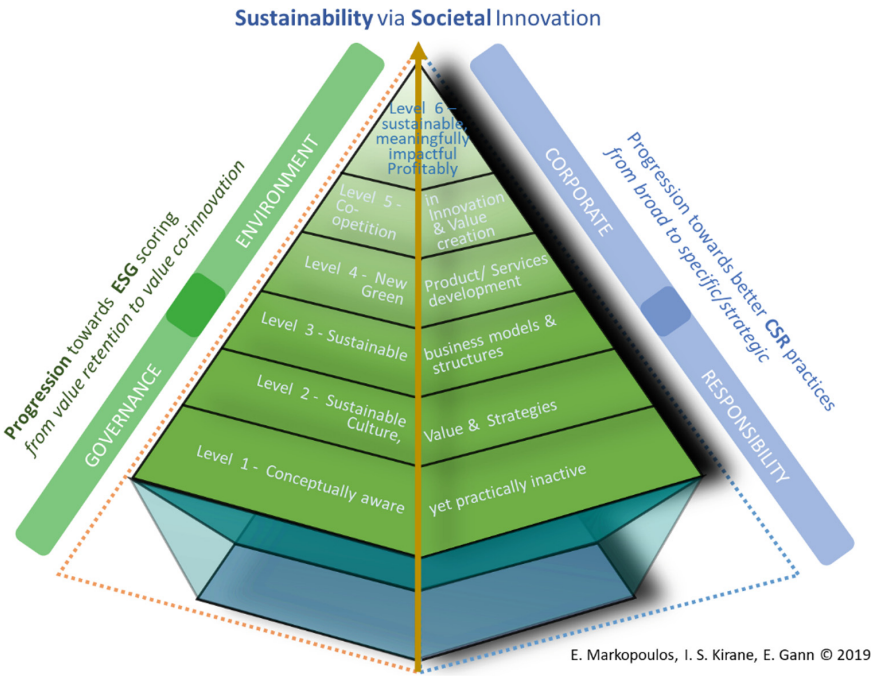

Fig. 7. The democratic ESG Green Ocean strategy model structure.

9 Applying the DeESGGO Model

The Democratic ESG Green Ocean Model can be applied from any type of organization regardless of its size and activity. ESG shall not be a rating privilege for large-scale organizations. Every company, small or large, can and should be thinking and acting under the ESG practices. However, the type of each organization impacts the time DeESGCO gets adopted and executed. There are various transformational archetypes categorized in the traditional companies, the multinational firms and the startups (Fig. 8). Traditional organizations or family businesses characterized by bureaucratic practices in their attempt to avoid mistakes and control their risk. Thus, they do not adopt modern management models and practices unless they are either forced by their clients, the government or impactful shareholders. In such organizations, the adaptation of DeESGCO can come at later stages of the Company Democracy model, usually at level 4 where the organization is at the innovation stage meaning that the product development has successfully passed the market acceptance stage (CDM level 3).

On the other hand, multinational organizations do not wait long to adopt modern practices. It is their continuous search for new organizational and reputational gains that drives management and the shareholders to be more adaptive to the industry trends and demands. Such organizations, in order to reduce the risk, but not be late market entrants, can adopt the DeESGCO at the second level of the Company Democracy Model, once they secured that there is enough knowledge in their organizations (CDM level 1) structured in proper teams to utilize it (CDM level 2).

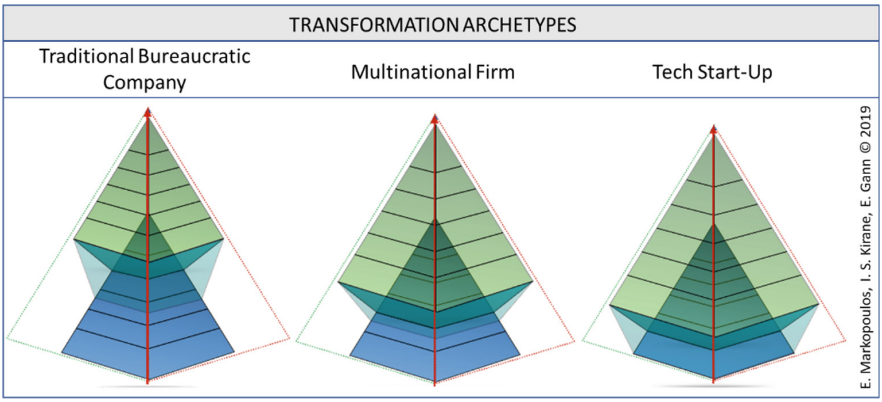

Fig. 8. The democratic ESG Green Ocean strategy model structure.

Lastly, there is the start-up type of organization, and especially the tech-driven ones which are fully aligned with the global trends as organizational culture and founder's culture as well. Driven by the millennials, the tech startups are fully aware of the ESG elements, they understand them, accept them, and seek ways to integrate them in their businesses and delivering products and services highly related to the consumer concerns.

These organizations do not lose any time to adopt DeESGCO as they don't have much to lose anyway. Therefore, DeESGCO is part of the first Company Democracy Model level and grows in parallel with the business operations since day one.

10 Conclusions

The ESG index is a modern trend in international business, impacting investments, profitability, reputation, marketing, client engagement and almost all the elements needed for an organization to sustain itself in a profitable way in a very competitive market. However, the very broad definition of the ESG concept does not allow the creation of a consensus between the rating organizations and the ones who invest in adapting such best practices. The distance that exists today in standardizing the ESG concept in rating and implementation creates opportunities for the researchers but significant challenges for the organizations. This paper attempted to approach the ESG challenges with the introduction of the Democratic ESG Green Ocean (DeESGCO) Model. The Democratic element contributes to achieving the Governance dimension while the Green Ocean Strategy contributes to achieving the Environmental and Sustainable dimension of the ESG. The paper introduced tools, practices and strategies for the application of the DeESGCO model such as the integration of the ESG and SCR, the Diagnostic Strategic Mapping, the Linear Transformation Process, the Transformational Archetypes and the DeESGCO model itself. However, true compliance with the ESG dimensions can only be achieved with the organizational culture and philosophy. It is easy to tick compliance boxes but not easy to convince that they have been really ticked. ESG is a valuable concept but it requires organizational leadership and self-awareness to bypass the political correctness and to practically comply with ESG for the shake of the organization, the society and the humanity.

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An AcciMap of the Edinburgh Tram Network Project Delivery Failure

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Abstract. This paper presents an AcciMap of the Edinburgh Tram Network (ETN) project delivery failure in Edinburgh, Scotland. The AcciMap is used to show how various factors contributed to the ETN delivery failure. The paper starts with the historic background of the ETN project, followed by the AcciMap output of the ETN project failure.

Keywords: Project · Project failure · AcciMap

1 Introduction

Proposals for the ETN project submitted to the Scottish Parliament received Royal Assent in 2006 [1–3]. The proposed tram network consisted of three phases (Fig. 1), which were designed to run through the City Centre of Edinburgh [4]. However, due to funding issues and the global economic downturn [4, 5], funding of all three phases was impossible, and for this reason, only two of them 1a and 1b received parliamentary permission [4–6].

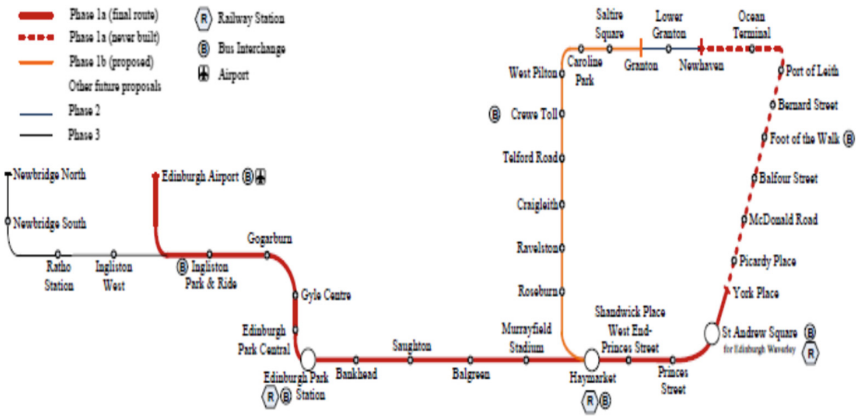

Fig. 1. Proposed route of the Edinburgh trams [3–6].

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Construction of the ETN was originally due to be completed in 2011 [6]. However, unforeseen issues, which included disputes among the ETN stakeholders, technical difficulties in the project, failures to meet specified quality standards, unfavourable climatic conditions affected the construction of the ETN (Fig. 2), caused major delays of the ETN project completion.

Works are causing disruption to drivers [7]

Utility diversion works delayed construction [8]

Fig. 2. Unforeseen issues that caused major delays of the ETN project completion.

Based on the relevant body literature, a list of the risks encountered at construction stage of the ETN was identified by Boateng et al. [9]. These risks will be used in constructing the AcciMap [10] output for the ETN project delivery failure. A number of features of the AcciMap will be explained in the next sections.

2 The AcciMap for the Edinburgh Tram Network Project

Figure 3 represents the AcciMap output, showing the initial events that led up to the ETN project not being delivered on time, from the lowest levels to the highest. Various contributory factors are placed at the bottom level of the diagram, at the equipment and surroundings level. These include the adverse environmental impacts due to construction work, unfavorable climate conditions for construction work and changes in material and energy price.

The social grievances, social issues and project time and cost overruns are included at the level of physical processes and actor activities. The various failures, including inaccurate project cost estimate, project technical difficulties, engineering and design change, technical difficulties in utilities diversions/ground condition problems,

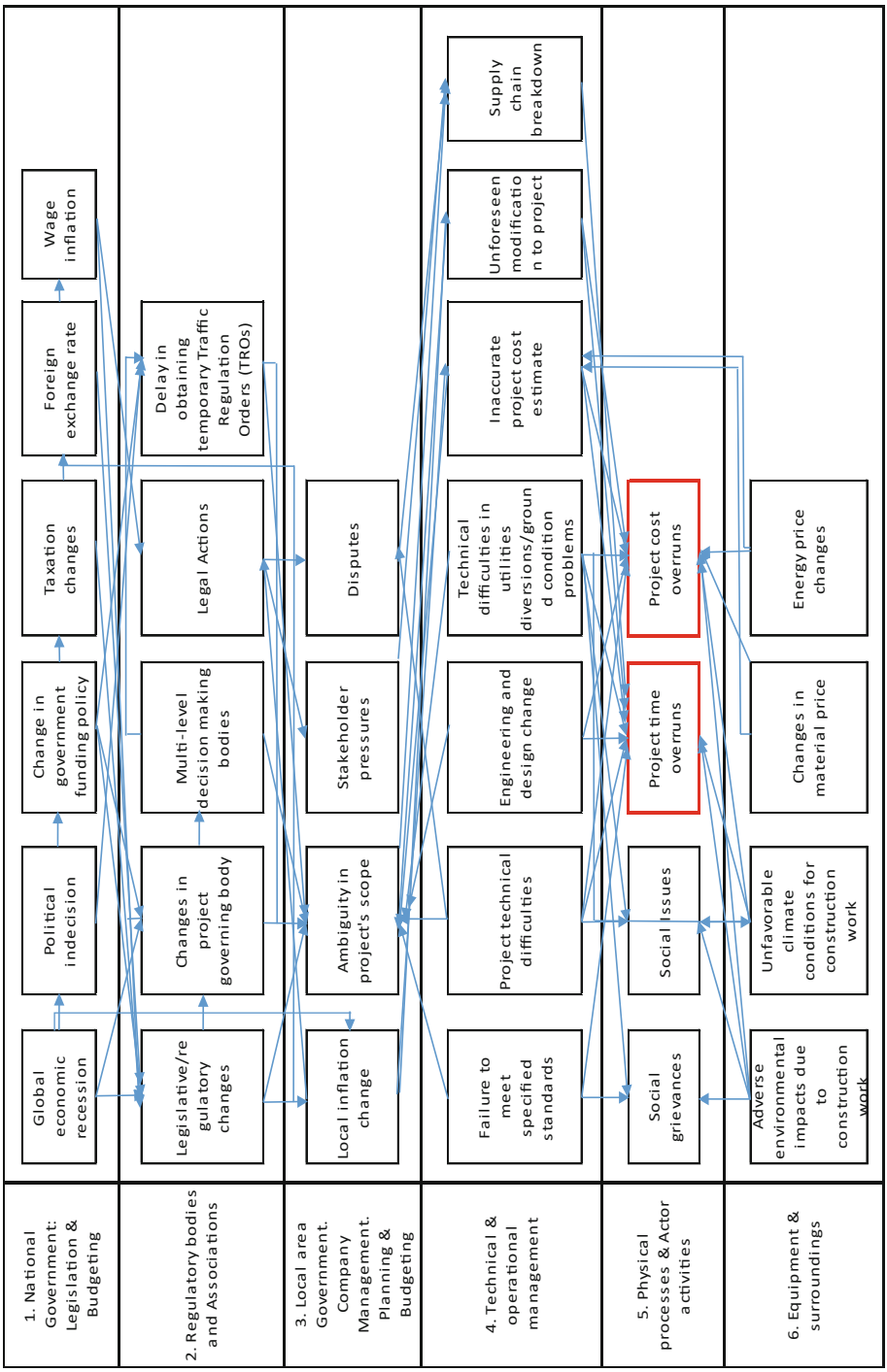

Fig. 3. AcciMap of Edinburgh Tram Network project

unforeseen modification to project, supply chain breakdown, failure to meet specified standards are placed at the technical and operational management level.

Various failures at the level of local area government, company management, planning and budgeting level also played a role in the ETN delivery failure. There were local inflation change, disputes, stakeholder pressures and ambiguity in the project's scope.

At the level of the regulatory bodies and associations, problems arose due to the presence of multi-level decision making bodies, changes in the project governing body, legal actions, legislative/regulatory changes, delay in obtaining temporary Traffic Regulation Orders (TROs).

Finally, at the national government level, the global economic recession, political indecision, change in government funding policy, taxation changes, wage inflation and the foreign exchange rate are included as factors which led to the failure of the ETN project to be delivered within an estimated budget and time.

3 Conclusion

This paper has summarised the background of the ETN project, focusing on the risk factors [9] that caused the ETN project delivery failure. The factors that led to these differences in project performance (usually being over budget, involving delays and quality deficiency) were classified into different levels via an AcciMap.

AcciMap is a way of representing describing the chains of causation at different levels in the system. An AcciMap is constructed according to a strict "but for" logic where the failure in project delivery that occurred would probably have been avoided by breaking any single link in the causal network.

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Workload and Visual Scanning Techniques of Expert and Novice Helicopter Pilots During Simulated Flight in Open Sea

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Abstract. The present study focuses on visual scanning techniques of expert and novice helicopter pilots during an open sea flight simulation in two different workload conditions. Twelve helicopter pilots were involved. Mental workload was assessed through psycho-physiological (EDA and HR) and psychological measures (NASA-TLX). The pilots' performance was assessed. Eye movements were recorded to analyse the differences in visual scanning techniques. More fixations were made OTW than ITC, but it did not differ between groups and conditions. Fixations were longer OTW than ITC, and they were shorter in high cognitive demand condition than low cognitive demand condition. Higher number of fixations was recorded on the centre line during landing, and on the instruments during cruise phase. The research highlighted that external conditions might change the visual scanning strategy of pilots. The implications for a new visual landing system design, as well as the limitations of the study are ultimately discussed.

Keywords: Mental workload · Helicopter pilots · Visual scanning techniques · Visual Landing Aids

1 Introduction

Manoeuvring a rotorcraft is a complex and demanding task. It requires monitoring an extensive amount of information, which consequently contributes to the pilot's mental workload. High levels of mental workload might reduce the pilots' ability to react to incoming information, increasing the likelihood of human error [1]. Additionally, insufficient situation awareness is one of the primary factors in helicopter accidents attributed to human error [2]. Helicopter flights can be broke down in different phases (i.e. Take-off, Climb/Descend, Cruise, Approach and Landing), each entailing different levels of mental workload [3]. More precisely, recent studies claim that the final phases of flight (e.g. landing) are the most demanding [4, 5].

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Performing a shipboard landing includes unique constraints, such as lack of visual cues [6, 7], restricted and unstable landing area [8], dynamic environment around the ship [9], and sea spray [10]. Additionally, mental effort requested to carry out necessary tasks can further increase during degraded visibility and rough weather conditions [6, 11].

The pilots' visual scanning techniques changes according to the flight phases and the task demands, but the literature shows ambiguous results. Researchers collected the number of fixations in three simulations of plane-landing scenario with a different difficulty level (modifying the visibility) in order to assess the pilot's mental workload. The results highlighted that the fixation frequency was significantly different among different scenes, but it did not change regularly [12].

Visual Landing Aids (VLAs) are a set of lights and signals that provide guidance to helicopter pilots for landing on a helideck aboard ships. Specifically, the main Out-of-The-Window (OTW) VLAs are the Glide Slope Indicator (GSI), the Horizon-Reference-Bar (HRB), the Deck Markings (which encompasses the Centre Line) and the Deck Reference Lights. The GSI provides the pilot with a visual cue for the right angle of the descent towards the ship. The HRB is a bar that remains horizontal, replacing the lost horizon, essential for the landing. On the other hand, the main Inside-The-Cockpit (ITC) instruments are the Compass and the Altimeter.

Some studies examined which VLAs are more useful according to the flight phases and conditions. The authors [10] collected pilots' opinions through a questionnaire. They suggested that in low visibility conditions, the GSI is the most useful device during the approach phase, while the HRB is mainly used during the landing phase. Others [13] observing two experienced pilots while performing shipboard landing simulations. The authors reported that during the first part of the flight, the pilots rely on ITC instruments, while during the final phase, they were more focused on OTW clues. Some authors claimed that novice pilots tend to ignore the visual horizon, which may lead to the mistake of following the ship's movements [5]. The pilots' decision to touchdown is guided by the visual aids on the ship's deck and the HRB becomes especially crucial in the night-time. The authors [14] provided a list of significant ITC instruments and OTW visual cues that the pilots use during different phases. The HRB, Deck Markings (which encompasses the Centre Line) and the Deck Reference Lights were found to be necessary for a correct positioning and final descent.

Other studies have shown that the pilots' expertise affect the frequency of visual scanning techniques from ITC to OTW [15–17]. However, whether expert or novice pilots look more OTW, or ITC, is not always clear and seems to depend on mission demands [18]. Interaction between flight experience and mission demands has been previously investigated [19]. The study revealed that expert pilots had more OTW gazes in low demand situations, whereas the opposite result was found for high demand situations. Pilots over-estimated the amount of OTW gazes and underestimated their instrument checks; this deviation was more pronounced among student pilots. The authors conclude that there are significant differences in visual scanning techniques of experienced and novice pilots when facing different mission demands. During the final phases, pilots need to maintain high situation awareness, elaborating information both from outside and inside the cockpit [19]. As the flight progresses, displayed information changes in real-time and must be closely monitored. Likewise, the visual clues

on the ship support pilot cognition, but they force the pilot to change the focus of attention from inside to outside the cockpit. The scanning of the cues OTW and of the flight instruments ITC requires frequent head-down movements which further increase the pilot's workload and the risk of generating vertigo phenomena.

Research has shown that efficient visual scanning is a skill that pilots need to develop, and there are significant differences between expert and novice pilots [20]. Therefore, there is a need for understanding effective scanning techniques, since visual attention is the most crucial resource of pilots.

2 Purpose

The present project aims to contribute in obtaining information that can be used to develop an innovative Visual Landing Aid, delivering an ergonomic, user-centred system that can reduce pilots' and operators' workload and increase overall situational awareness. We adopted the experimental procedure in [19] addressing visual scanning techniques of pilots during different phases of flight, and the effects of flight experience and mission demands. In particular, the value of the VLAs OTW and the instruments ITC during the different phases of flight are assessed.

3 Method

Twelve male helicopter pilots (6 experts and 6 novices) voluntarily took part in the study. We have defined an arbitrary cut-off for flight hours to differentiate between expert and novice pilots: novices < 1500; experts > 1500 flight hours. All participants accomplished two flight simulations, the first in daylight and fair weather (low task demand condition) and the second in the night-time and bad weather conditions (high task demand condition). The simulations started with the helicopter on a ship's deck, and the goal consisted of take-off, flight and land on the same ship.

After each simulation, the pilots fulfilled the NASA-TLX questionnaire, and the pilots' chief assessed their performance on a single item (from 1 very poor execution, to 10 excellent execution). Pilots' electrodermal activity (EDA) and heart rate (HR) were collected using the E4 Wristband by Empatica. EDA and HR were considered as an objective measure of mental workload [22].

Each pilot's visual scanning technique was recorded using Pupil-Labs eye-tracker [21] in terms of number and duration of fixations. The VLAs OTW and the instruments ITC were codified in Areas-Of-Interests (AOIs). Specifically, the AOIs encompassed five categories: Instruments, OTW, HRB, Centre Line, Ship Deck. The AOIs were mapped in the raw videos manually.

4 Results

Our results confirmed that low visibility conditions and rough sea have a detrimental effect on pilots perceived Mental Workload ($F(1, 19) = 7.33$, $p < .024$). Expertise could play a role in mitigating such effect ($F(1, 19) = 4.76$, $p = .055$). EDA and HR

data did not reveal significant differences. The negative effect of the Condition on pilots' performance is confirmed by our results, showing that all pilots perform worse when the task demand was higher ($F(1, 18) = 20.73$, $p = .0067$).

The number of fixations doesn't change according to the level of expertise or the flight condition, although their durations were longer in High Workload condition than in Low Workload condition ($F(1, 96) = 4.66$, $p = .033$). According to phase of flight, the number of fixations ITC or OTW changed ($F(3, 96) = 46.25$, $p < .000$). The number of fixations is overall higher OTW than ITC, except for the cruise phase, in which pilots made significantly more fixations ITC compared to OTW, and that is true both for novice and expert pilots. The duration of fixations was longer when made OTW compared to ICT ($F(96,1) = 15.53$, $p = .0002$). Specifically, the number of fixations change according to the AOIs during the landing phase ($F(3, 30) = 4.14$, $p = .016$). In particular the pilots focus the attention on the Centre Line, instead of the Ship Deck and the HRB. Fixations were longer in Low Workload condition than High Workload condition ($F(1, 24) = 4.73$, $p = .044$) and the fixations on Centre Line were longer than on other AOI ($F(1,24) = 5.88$, $p = .0059$).

5 Discussion

We expected that HR and EDA scores would significantly differ between experts and novices, depending on the flight phase or condition. However, our results did not reveal any significant difference in terms of EDA and HR variability. A possible explanation could be that pilots are required to go through many hours of intensive training and courses during the military academy, which would prepare them to deal with difficult flight situations and create a dampening effect in pilots' physiological reactions.

Experts reported a lower mental effort compared with novices, while higher mental workload scores were reported by both groups in the difficult condition if compared to the easy condition. Our results also confirm that low visibility conditions and rough sea have a detrimental effect on pilots perceived mental workload and that expertise plays a role in mitigating such effect. The negative effect of the condition on pilots' performance is confirmed by our results. All pilots perform worse when the task demand was higher.

Expert pilots had fewer fixations than novices, but their duration was similar. The number of fixations is higher ITC than OTW in cruise phase. This result supports previous research. In fact, when cruising, pilots often remain without meaningful visual cues on the exterior, thus focus their attention on instruments such as altimeter and compass. The condition is reverted in the following phase, the approach, when pilots need to redirect their visual attention towards the ship, align with its rear, and set the descending angle basing on the GSI. Our results confirmed that this is true both for novice and experts. The situation remains vastly similar even in the landing phase when pilots focus on external clues such as the centre line. Furthermore, results on fixation duration showed that OTW fixations are significantly longer than ITC fixations. This suggests that the most crucial info for pilots are gathered through looking outside of the cockpit. Critical information ITC (e.g. altitude) are still needed for the pilot but he/she has to switch attention to the instrumentation and then again OTW. This could entail

the onset of spatial disorientation phenomena which are deemed a relevant risk. Generally, the pilots' skills in monitoring the environment and the helicopter's instruments are essential factors that affect the decision making and the safety of the flight.

Regarding future studies, there is the need to investigate the relationship between mental workload and physiological data in experts and novice pilots. Furthermore, a study [15] revealed that more experienced pilots had shorter gaze duration and more frequent saccades between the ITC and OTW. Future studies could focus on saccade measurements.

The present study contributes in deepening the knowledge regarding mental workload and gaze behaviour of helicopter pilots landing on ships. It is worth to discuss that higher mental workload and worse performance could critically affect safety of the pilots and their crew. Indeed, new system that gathers all the crucial information needed by pilots in such situations could be beneficial for increasing safety. Implications are relevant for organizations involved in developing systems and interfaces to reduce pilots' mental workload, improving their visual scanning techniques and ultimately increasing pilots' safety and operations success rate.

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Kansei Design and Its Applications in Architecture and the Built Environment

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Abstract. *Kansei* is a Japanese term referred to human feelings activated at emotional level, once in contact or relation with a particular object or context. The *Kansei Engineering* (KE) method developed by Mitsuo Nagamachi in the 1970s introduced the *kansei* approach into design community for the first time. In this regard, *Kansei Design* (KD) is a novel holistic approach to users' perceptions at cognitive level which seems appropriate to applications in architectural design. Scope of this paper is to investigate about specific approaches and methodologies currently adopted in KE and KD, which are mainly focused on intrinsic characteristics of artefacts, and their possible extension to applications in the fields of Architecture and Built Environment in terms of emotional quality of forms and spaces.

Keywords: Kansei Design · Kansei Engineering · Semantic differential method · Architecture and Built Environment

1 Introduction

Kansei is a Japanese term used to express one's impression towards artefacts, situations, and surroundings [1]. Deeply rooted in Japanese cultural background, the term has not a direct English translation, seemingly corresponding to the ideas of "sensitive recognition", "sensitivity of affection", and "emotion", even if these definitions are not comprehensively recognized by all researchers in this field [2]. Consequently, the kansei approach and methodologies in design development have been recognized only lately in the western world. Research about human feelings and emotions, especially in relation to art and design, has notoriously fostered vibrant discussions since the studies of Kant and Baumgarten about the 'cognitio sensitiva' (sensitive awareness) and psychology of emotion, to which the philosopher William James attempted authoritatively to answer in 1884, starting an ongoing debate which is still vigorously alive [3]. Methods to record scientifically peoples' cognitive perceptions, both quantitatively and qualitatively, have always represented a focus in any social research. With the inception of industrial mass-production, the scientific approach extended also to researches in marketing and design, with the goal to satisfy a growing demand of differentiated commodities within a market progressively saturated by products functionally similar. The development of analytical methods like the Semantic Differential (SD) by Charles E. Osgood in the 1950s, and engineering approaches to quantify users'

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needs in relation to artifacts, like the Quality Function Development (QFD) by Shigeru Mizuno and Yoji Akao in the 1960s, and the Kano model by Noriaki Kano of Tokyo University in the 1980s, marked a progressive shifting of industrial production from a design-centered approach to a new user-centered philosophy applied to products and services. In this context, the method developed during 1970s by Professor Mitsuo Nagamachi of Hiroshima University, and officially presented as Kansei Engineering (KE) in 1986, uses the concept of kansei as a tool for product development based on emotional responses of users, or better, it applies a statistical methodology to individuate the kansei feeling of users about a specific product. This methodology gained an almost immediate success in Japan, responding to a rising demand of products' personalization and differentiation, becoming rapidly popular between manufacturing companies and introducing the kansei approach into design community for the first time [4]. Initially developed as a methodology to translate users' feelings into user-oriented product design, the kansei concept evolved borrowing methodologies also from other fields, like Kansei Science (KS), a trans-disciplinary approach to design through cognitive neuroscience and psychophysiology [5], and more recently into Kansei Design (KD) as a novel approach strictly based on design and design research [6]. Specifically, KD emphasizes its character of pure research about the hidden mechanisms of emotional design even going back to the philosophical source of kansei, adopting a holistic approach to users' perceptions at cognitive and psychophysical level, hence joining KE and KS' methodologies, including perceptive reaction to aesthetic qualities, space awareness, sensorial stimuli, and feeling of appropriateness of forms and spaces. Since it is considered a new domain, most of KD's theoretical framework is in process and constantly under further development [7–9].

Scope of this paper is to investigate about specific approaches and methodologies proposed or adopted in KE and KD, which are mainly focused on intrinsic characteristics of artefacts, in searching for a possible extension to applications in the fields of Architecture and Built Environment in terms of emotional quality of architectural spaces. Therefore, this study is not proposing an alternative approach or another statistical tool, as more posing the question if these methodologies, and KD in particular, have the characteristics to be applied also in architectural design. Hence, a preliminary definition of a supposed Architectural Kansei [10] is introduced, especially in the case of community spaces shared by a heterogeneity of users. Fields of application of this concept could be extended to qualities' assessment of special interior architectures, such as hospitals, schools and working places, including the internal definition of habitats in remote areas and extreme environments, where the affective and emotional quality of interior spaces would substantially contribute to the psychophysical well-being of the occupants living in isolation.

2 Kansei Engineering and Kansei Design

Kansei Engineering (KE) has been described as "a proactive product development methodology, which translates customers' impression, feelings and demands on existing products or concepts into design solutions and concrete design parameters" [11]. The scope of KE is to make a specific industrial product in the market more

captivating than others with similar functionalities, activating an emotional feeling in the user, based on preliminary research about what actually activate such emotion statistically surveyed from a representational group of users. The development of a product in which functionality and affectivity would be fully expressed is the goal of every industrial company. In between the range of industrial products available nowadays, perhaps the last generation of electronic devices possesses such characteristics, transcending their pure functionality to become companion or fetish; e.g. the mobile phone for youngsters, or Mac brand products for digital enthusiasts. In that, fashion design has a similar emotional approach in developing products for which the user would feel compulsive attraction, enforced by an aggressive marketing and a pervasive advertising. Coincidentally, one of the first industrial product in which the KE methodology has been successfully applied is a passenger car, an industrial product that has been often associated to fashion design. The roadster Miata manufactured by Mazda, better known as MX-5 in the western market, is still recorded in The Guinness Book of Records as the world's bestselling two-seater, convertible sports car in history, well after three decades from its first launch in 1989. Most of its success relies in the approach which has been adopted since the beginning of the design process, prefiguring a product in which every detail would be engineered to attract emotionally a specific range of users, in this case younger drivers, making them the core of the whole design concept. The immediate commercial success in Japan first, and in western markets then, revealed the full potentials of KE in developing a user-centered product.

A detailed presentation of KE methodology is not the focus of this paper, for which specific articles are included in the Reference [12–14], however it is important to remark that basically KE uses advanced statistical analysis tools to translate feelings, habits and behaviors toward a specific product from a largest as possible selection of potential users. These inputs are selected and arranged into a series of "kansei words", grouped by category and arranged in a tree structure, originally using the Semantic Differential (SD) methodology, then some of these are integrated as design specifications and phrased as physical characteristics of the product [15]. In substance, each kansei word, or phrase, expresses a particular desired quality or feature which should be included in the future product, and therefore capable to activate the kansei, or emotional feeling, in the cognitive perception of the buyer. The range of kansei words spaces from physical description like form, color, texture, touch, sound and smell, until intangible characteristics like elegant, sporty, sophisticated, aggressive, retro, innovative, and so on. Hence, more kansei words are individuated, better would result the qualitative description of the artefact, which is still at the concept stage. The process in associating a characteristic with an emotional feeling is necessarily subjective, and responses would mutually exclude each other. In that, the SD method seemed perfectly suitable to individuate a common pattern in users' responses, distilling a median number of concepts expressing an envisioned user experience, which can be translated into design requirements. Therefore, KE is not a new systematic approach to design, but an innovative methodology in helping designers to respond to users' desiderata, hence developing a product which should be capable of. Particularly interesting are the applications of the KE System (KES) Type IV, or Hybrid Kansei, in which two phases are considered: a first one called "Forward KE" follows the linear procedure of kansei words outputted as design details, and a second one called "Backward KE", in which

sketches and preliminary draft models are digitally compared with a database of words and images through a backward inference engine, estimating the level of kansei achieved for that specific product [16]. Mostly of existing literature about kansei concept and its application in design focuses about use and development of statistical analysis tools, probably missing what really is kansei. Paradoxically, one of the strengths of KE methodology, the scientific accuracy of analysis, could be reversed into one of its weaknesses, especially in terms of time and costs. The process is quite long and the elaboration of data involves a quantity of specialized personnel, surveyors, statistical analysts and market researchers, before to land on designer's table [17]. Therefore, is not surprising that KE has been fully used, and successfully indeed, for industrial products with a consistent market distribution of several thousands of units. Along the years, the KE approach has been implemented and fine-tuned with introduction of different tools applicable to different contexts and products, revealing a high degree of adaptability of its structure and purpose.

As briefly mentioned in the Introduction, Kansei Design (KD) is focused on theoretical aspects of design, intending to rediscover the original Japanese philosophical meaning of kansei, and use it as inspirational source for design [8]. It is interesting to note that, differently to KE, the supposed field of application of KD could be extended to the whole spectrum of design, and not necessarily tied down to a certain category of products, in searching for the intimate relationship in between designer/artefact/user, and the psychological mechanisms of artefact's enjoyment. As Pierre Lévy noted, "KE literature has often used the term *kansei design* to characterize KE works which produce actual industrial product as their output. However, it is clear that these works are within the realm of KE, because they are bonded to an engineering approach, as opposed to KD which is yet another approach" [7] (p. 89). In KD, the designer's role is reaffirmed, assessing the received inputs mediating through his or her own kansei and experience, hence, KD could be reasonably considered an evolution of KE and not a derivation. The flux of information coming from preliminary survey needs an interpretation, and in this translation the team work of designers, their experience and intuition play a fundamental role. With reference to the philosophical origins of kansei, the KD methodology takes in great consideration the Japanese tradition for craftsmanship, and capability of artisan's kansei to reach end users through the artefact, which acquires meaning through the intentionality of its creator. Then, Lévy individuates two main groups of projects elaborated through KD approach: a first group focused on physical materiality of artefacts, i.e. their intrinsic properties and characteristics, and a second one based on the interactive materiality, which is the qualities of artefacts in interaction. Based on this definition, we therefore suppose that architectural spaces could be included in the second group, not as artefacts in interaction but as the very place of interaction of users with artefacts.

3 Kansei and Architecture

Most of current literature about kansei methodologies applied to design is focused on product design, or design of human-machine interface, whereas a minor part investigates about a possible adoption of this approach into architectural design theory and

practice. The reason, in our opinion, is due by the intrinsic nature of architectural design process which is often based on designer-centered decisions. Actually, the mission of building architecture is to contribute to the well-being of its occupants, both functionally and aesthetically. Contingencies like designer or customer's egos, costs, contextualization, timeframe, and restrictions imposed by regulations make the architectural object unique and unreproducible, therefore hardly to be categorized as mass-product even if actually the most used human artefact. Despite that, a consumption of architecture like any other commodity exists, as revealed by social media and advertisements. Millions of pictures posted on Instagram, Facebook or Twitter are often portraying a particular architectural frame which is positively or negatively perceived, then deserving to be shared with the community to rise or decrease its popularity. The mass-tourism phenomenon also, continuously sells and consumes the architectural product represented by cities, hospitality, cultural facilities and transport infrastructures, supported by marketing strategies like 'city branding' in selling the urban enjoyment like any other commodity sector. The idea of architecture as an artefact which is used and consumed like any other product could be erroneously interpreted as negation of its outstanding and uniqueness. Undoubtedly, the message embedded into architecture transcends the pure functionality in arranging forms and spaces, and neurosciences evidenced that there is a correlation between psychophysical well-being and environmental characteristics of spaces. In this regard, the application of KE and KD methodologies seems particularly appropriated in the case of highly specialized habitats in extreme environments, such as Antarctica and outer Space, where functionality associated to a recognizable architectural environment would contribute to the psychophysical comfort of occupants living in isolation.

4 Conclusions

Architectural spaces conceived for a heterogeneity of users could be designed following kansei approach, especially ones with a high consumption rates in terms of message and usability. Particularly, the reference is to commercial spaces which are periodically refitted to satisfy commodity-related changes and/or customers' tastes, or community spaces such as hospitals, schools and working places where the individuation of a common emotional pattern would improve the well-being and productivity of users. Therefore, such pattern could be mapped through SD method, associating semantic and visual description for the specific domain in which a common kansei pattern is searched. This methodology eventually would join the User Feedback Survey, currently adopted for post-occupancy evaluation, and the Architectural Programming which is focused on functional definition, helping designers from concept stage in selecting the most appropriate characteristic of spaces to match the desiderata expressed by users. Concluding, the supposed Architectural Kansei would therefore represent a more systematical approach to community architectural design, supported by use of digital tools such as Virtual Reality and visual simulations, as currently used in KES Type V or Virtual Kansei, to test users' experience before design finalization.

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Avoiding Post-Merger Corporate Downsize Restructuring: The Democratic Employee-Culture Fit Model (DeECFit)

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Abstract. One major challenge in Mergers and Acquisitions is the best possible utilization of the human resources organizations offer. The judgment on employee redundancy is often highly controversial and risky. It can impact the motivation of the remaining employees, the corporate culture, and the reputation of the firm in the market. This paper addresses this challenge by introducing the Democratic Employee-Culture Fit Model (DeECFit) for Post-Merger Corporate Restructuring to avoid downsizing practices and maximize the utilization of the available human resources and intellectual capital. The model describes the relationship between the definition of the cultural values and the concentration of democratic values needed for an employee of either company to effectively join the Merger and operate under a symbiotic model by utilizing their human recourses. The democratic approach of the DeECFit Model provides the opportunity to all employers from both organizations to prove and justify their place in the Merger.

Keywords: Merger · Acquisition · Democracy · Downsizing · Rightsizing · Finance · Organization · Culture · Management · Human recourses

1 Introduction

Mergers & Acquisitions (M&A) are common strategic tools for companies to acquire innovative products, capture new markets or simply scale on growth opportunities.

The main reason for M&A deals is synergies [1], for value creation. However, establishing effective synergies requires intensive efforts to successfully retain, realize and further create value through the utilization of the human resources. Value creation

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from synergies is expected and traded at the acquisition price and should be ensured from the post-merger integration onwards. Synergies rely on expected cash flows drawn by valuation models prior to and during the deal, but also on operations management, which is impacted by the corporate culture. Corporate culture relies on elements such as organization management, visions & values, ethics, stories, common practices processes within the company's space and human intellectual capital. However, despite the critical role of the organizational culture in the merged organizations for value preservation and realization, the integration and human resources activities, are limited in an M&A process approach. Such activities deal with understanding and comparing H&R practices between the bidder and the target; assessing the culture of the target, guiding behaviors and attitudes of negotiators and due diligence teams, creating an integration transition structure, etc. [1].

2 Merger and Acquisition Challenges

Mergers and Acquisitions can offer strategic advantages. However, the unique nature of an M&A deal imposes risks realted to the business activities. Evidence shows that in most cases, organizations would have achieved better returns via bank account savings and investments, rather than acquisitions [2]. One popular reason for failures is wrong estimations of the M&A potential. Less benefits from economies of scale and scope, lead to wrong revenue estimates which imply over-valuation of share prices that drop the stock price value [3]. Furthermore, human capital, resources and knowledge are often underestimated in the M&A and the Post Merger Integration (PMI) processes. There is a taboo in engaging in human capital restructuring conversation, as this is often synonym of redundancies. According to McKinsey, 95% of the executives believe that cultural fit is "critical to the success of integration" and still, 25% describe the "lack of cultural cohesion and alignment" as the main reason for integration failure [4]. The absence of the proper understanding on the organizational culture results in demotivated employees or even withdrawal of the "key people" [2], reduces the loss of important knowledge and diminishes the synergies potential.

A renown example of a Merger failure attributed to cultural differences is the Daimler-Chrysler case. The two company cultures were at war from the very beginning due to different levels of formality, different expense philosophies and different work approaches, leading to huge financial losses and eventually many lay-offs primarily from Chrysler. With 60% of deals negative impacting shareholder value [3], clearly, it is not an easy tool to apply for strategic advantages. Despite those challenges leading to a failure rate of 83% on the long-term of M&A deals, they are still on the rise with a worldwide increase of 8%, according to the Institute of Mergers, Acquisitions and Alliances [5].

3 Identifying, Engaging and Retaining Human Recourses

Organizational culture is a key challenge corporate merges face on achieving the expected synergies during M&A deals. Such synergies are not always effectives due to cultural discord. This paper attempts to provide a democratic approach to Corporate

Cultural Fit in Post-Merger Integrations on achieving the best possible utilization of human resources whilst avoiding (deleterious)downsizing oriented restructuring. The model addresses the mindset required by decision-makers & due-diligence teams on the topics of effective organizational restructure based on a cultural blend and human intellectual capital identification. This mostly entails on the identification and development of the human resources skills and abilities on their roles or the value expected to create in the merge, in order to avoid downsizing, meaning laying off employees who seem redundant.

Identifying and managing employee redundancy is one of the major challenges in the PMI (Post-Merger Integration) phase. Such a process comprises various levels of risk, embedded in each other, adding to the risk management and due diligence difficulty, leading to significant legal, and operations implications. It can impact the motivation of the remaining employees, the corporate culture, and the reputation of the firm to the market (press, customers, government). Examples of such risks can be found in historic merger failures such as the Daimler-Chrysler [6], Novell-WordPerfect [7] as well as the AOL-Time Warner Merger [8] and many others. Forbes estimated in 2015 that 83% of mergers fail for many reasons with the lack of forming common corporate culture to be a key one [9].

4 Democratizing the Employee Culture Fit in Post Mergers and Acquisitions

The reduction of the excess human resources in M&A impacts the employees who remain in organizations due to the fear of being in a similar situation sooner or later. Studies that tracked for nine years the performance of organizations that adopted downsizing strategies do not indicate outperformance against the ones who didn't [10]. Organizations with business environments that emphasize people-management practices, culture, and capabilities achieve competitive advantage [11]. Such practices emphasize on achieving the feeling of fairness among the employees. By applying fair processes, organizations reduce employee turnover, recruitment costs and legal cost, whilst generating knowledge that can support strategic initiatives, but also ignite an innovation-based culture [12].

To achieve organizational fairness especially in organizations formed from Mergers and Acquisitions, where organizational cultural differences significantly impact such a symbiosis, the concept of democracy on speech and actions can be applied. This research work presents the Democratic Employee-Culture Fit Model (DeECFit) for Post-Merger Corporate Restructuring. The model is based on the Company Democracy Model [13, 14] and is structured through six evolutional operations levels. Those are evolved under three dimensions with each dimension to form a different organizational culture element all of which are needed to create the post-merger and acquisition organizational culture. To apply the DeECFit it is important to identify the concentration of democratic values needed for an employee of either company to effectively join the Merger. This is achieved by several challenges given to the employees on which they respond to demonstrate their value in the new organization while adopting the various cultural dimensions during the PMI phase.

The model starts from the first level where the Merger challenges are introduced, and human resources skills and intellectual capital is identified and evolve all the way to level six where the challenges are resolved through the adaptation of the new organizational culture. The process provides two main outcomes to the merged organization. First, it identifies the employees willing and being able to join the merge, and second the knowledge generated from the challenge given. This knowledge can turn out to be the determinant factor and a base for either aligning the new organization's culture based on the human resources skills and intellectual capital or restructure the human resources to be aligned with the new organizational culture and strategy adaptation.

5 The Democratic Employee-Culture Fit Model (DeECFit)

Affective organizational cultures combine several dimensions in management and operations. The DeECFit Model is a culture driven classifying such dimensions under its Democratic Dimension, Value Chain Dimension and Culture Dimension (Fig. 1).

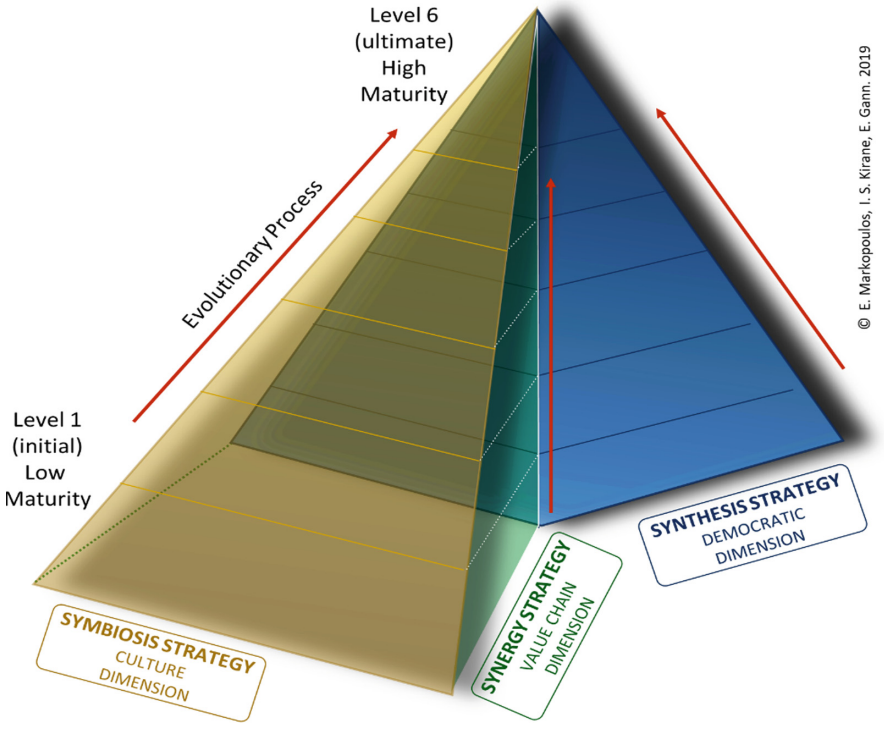

Fig. 1. Dimensions and Strategies of the Democratic Employee-Culture Fit Model

Each one of the culture dimensions is composed of six maturity levels forming a specific culture for each. The combination of these cultures forms the Post Merger/Acquisition Integration culture adopted by the employees of both organizations towards identifying their best place in it.

The model provides the opportunity to all employees from both organizations to prove and justify their position in the merge while working under a common goal, forming the new post-merger organizational culture. The inner layers of the DeECFit Model form the operations strategies while the outer form the symbiosis strategy.

Specifically, the Democratic Dimension is based on the Company Democracy Model on building innovative competitive and globalized business operations. The model is driven by the values of democracy through which all the employees in the new (merged) organization can contribute to the success of the merge with their skills and intellectual capital. The Value Chain Dimension is based on value created through the democratic operations of the organization by increasing the organizational knowledge substantially and decreasing the dependability of the organization from external partners and suppliers. The Culture Dimension is based on the integration of the organizational culture each organization had prior to the merge, and the development of the new organization's culture through the operations that take place in the Value Chain and Democratic Dimensions. In other words, democracy ignites knowledge generation and utilization which creates an organizational value, which shapes the new post mergers organizational culture.

Each one of the DeECFit Model dimensions contributes to the development of the Post-Merger Integration organization strategy (Fig. 2).

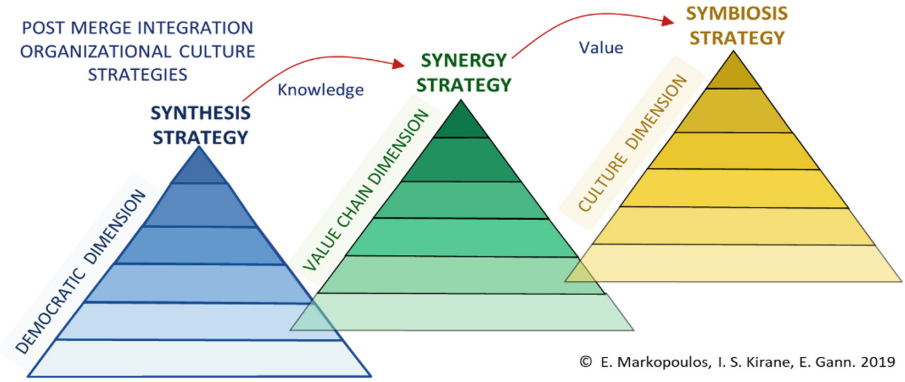

Fig. 2. DeECFit Model Dimension and Strategies Dependencies

The Democratic Dimension contributes towards a human resources synthesis strategy in which the employee's skills and intellectual capital is revealed through a career rewarding process. The Value Chain Dimension contributes towards a synergetic dimension between the human resources of the merged organizations to create a value chain process through complementarity and supplementary. Lastly, the Culture Dimensions contributes towards developing the Symbiosis Strategy by retaining

characteristics from the organizational cultures of each merged organization and builds on them based on the evolution and effectiveness of the Synergy and Synthesis strategies.

6 The Democratic Dimension and the Synthesis Strategy

The democratic dimension of DeECFit Model for the Post-Merger Integration organizational culture is composed of the six levels of the Company Democracy Model and its actual implementation process (Fig. 3).

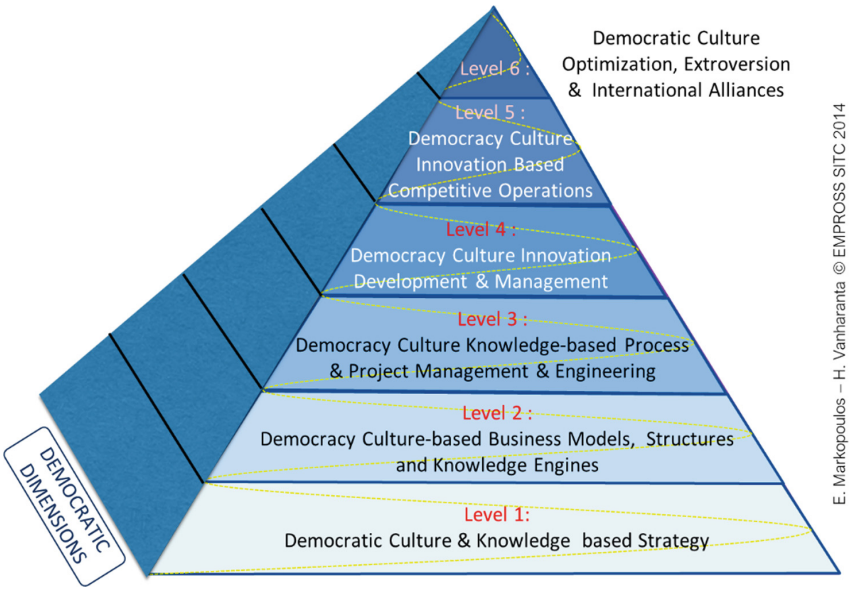

Fig. 3. The six levels of the Democratic Dimension in the DeECFit Model

The first level of this dimension provides a democratic culture where any employee from the merged organizations has the freedom and opportunity to share skills, knowledge, ideas, insights, and even visions and strategies. It is a level where fairness and equality are applied to all who feel that need to be treated fail and equal, seeking the chance and opportunity to demonstrate their value in the merged organization. The effectiveness of the first level impacts significantly the rest. The second level is based on the formation of teams around the ones who share knowledge in order to apply it on level three and turn it into innovation at level four. Level five identifies the competitive advantage gained from level four and with this advantage the organization can achieve international and global activities, partnerships and operations.

This Democratic Dimension implements the Post Merge Integration Synthesis Strategy as it blends the human resources form the two merged organizations under a

democratic framework where they can equality collaborate, cooperate and co-evolve. It is a strategy that can, later on, determine the active employees from the non-active, the happy from the unhappy, and the engaged from the disengaged. With such a practical and fair employee evaluation the organizations can decide the degree of the downsizing strategy needed, and the ones that will be affected in the short and long run.

7 The Value Chain Dimension and the Synergy Strategy

The Value Chain dimension of DeECFit Model for the post-merger integration organizational culture is composed of the six levels related to the Company Democracy Model and the Democratic Dimension. However, the goal, in this case, is the creation of a value chain that will be feeding the organization with the added value towards detaching itself from unnecessary and/or ineffective suppliers, partners and subcontractors. This is achieved by the effective utilization of the excess human recourses after the merger, to delivering value that was acquired from externals (Fig. 4).

The first level of this dimension emphasizes on identifying the needed value chain elements for the organization to successfully and effectively operate after the merge. This is achieved by mapping the expertise and knowledge acquired by the organization from externals (suppliers, subcontractors, etc.), against the larger human resources pool the merged organizations now has. This mapping aims to direct the employee skills and intellectual capital towards delivering the needed work and service value that used to be outsourced. Based on the identification of those needs, level two creates the related teams, units and structures to work on them. Level three promotes co-opetitive, and not competitive management by supporting the teams of level two to work effectively and

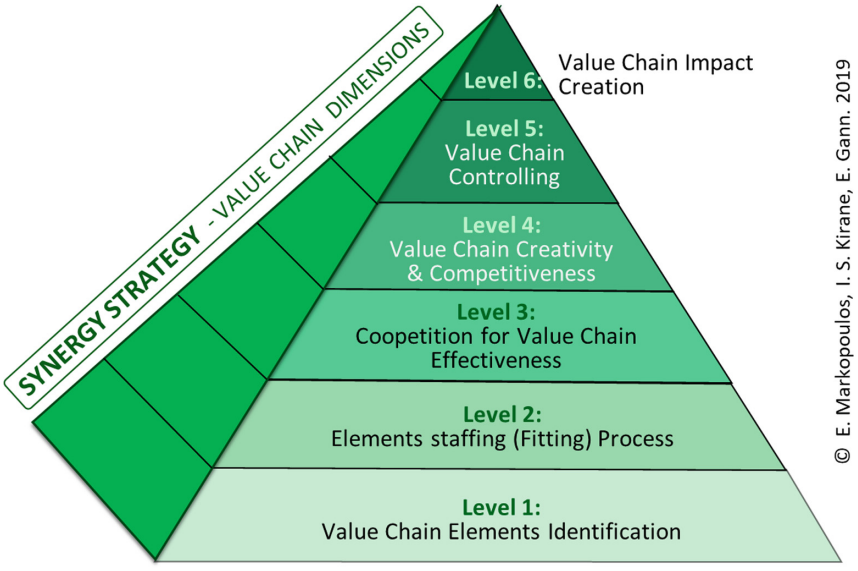

Fig. 4. The six levels of the Value Chain Dimension in the DeECFit Model

deliver the needed value. Level four builds on the value delivered by level three on turning it into competitiveness with creative operations, service innovation, patents, etc. Level five emphasizes on maintaining control of the value created, and keep on building on that from derivative elements, needs or enhancements. Lastly, level six commercializes globally the value created and measures it by its impact on the market, the economy and the society. At this level, the organization can export the added value created from the activities of this dimension.

This Value Chain dimension implements the Post Merger Integration Synergy Strategy as it synthesizes the new skills, expertise and intellectual capital of the new organizations to gain control over its operations by getting detached from its suppliers. The more value created by the new organization, the less will be spent on suppliers and external experts, and more autonomy and security the organization will have.

The Synergy Strategy differs from the Synthesis Strategy which is driven by the democratic dimension. The Synergy Strategy directs its employees on delivering specific needs, products or services the organizations obtained from externals. On the contrary, the Synthesis Strategy does not have specific requests from the employees but offers them the freedom to share and develop their knowledge and ideas best for the organization but not necessarily aligned with a specific goal such as the decrease of dependency from a supplier. A common denominator of the two strategies is that they both identify the performance and engagement of the employees to work together for the common good of the new organization. This performance impacts the need and the degree downsizing actions could have been taken otherwise.

8 The Culture Dimension and the Symbiosis Strategy

The Culture Dimension of DeECFit Model for the post-merger integration organizational culture is composed of six levels that act as an organizational culture umbrella over the Democratic and the Value Chain Dimensions. The goal of this dimension is to develop the new organizational culture by initially utilizing elements from the organizational cultures of the two merged organizations and enhanced them with the activities and work delivered in the Democratic and Value Chain Dimensions (Fig. 5).

The first level of the Culture Dimension emphasizes on the retention of organizational cultural elements from the merged organizations. The more cultural elements from each organization are visible in the new organizational strategy the more engaged the employees will be. This is the most critical level of this dimension as the selection of the organizational culture elements that will be kept and integrated into the new organizational culture must be the ones the employees felt comfortable and proud to have around and work with. The second level emphasizes on the homogenization of the elements of level one towards integrating them with new organizational culture elements that did not existed in the pre-merged organizations but are critical for the new organizational culture. Such new elements can derive from the Democratic and Value Chain dimensions and can evolve in the organizational culture. The third level institutionalizes the new organizational culture as a standard practice, and level four optimizes the organizational culture by integrating best practices from the industry. Level five evolves the successful organizational experiences into innovative and

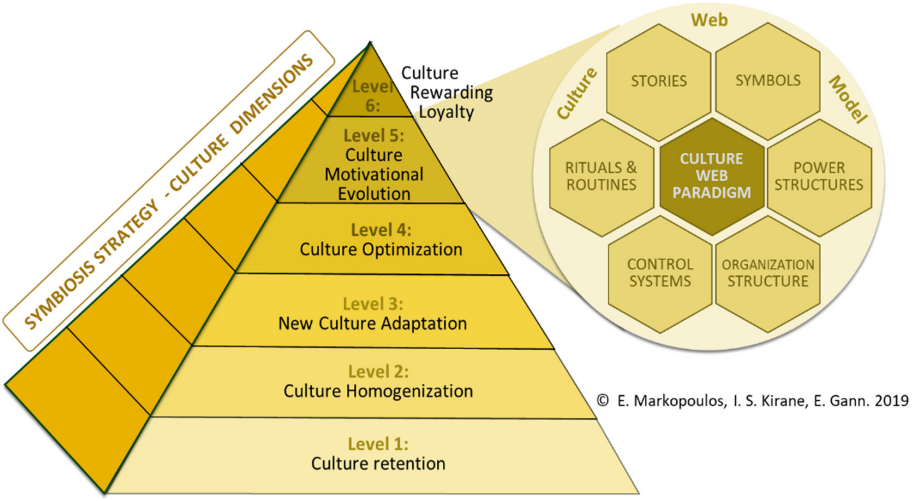

Fig. 5. The six levels of the Culture Dimension in the DeECFit Model

motivational organizational culture elements though the culture web methodology [15] to extend the organizational culture beyond management and operational processes. Lastly level six aims on achieving employee, client and partner loyalty from the effective execution of the previous levels in conjunction with the effects of the Democratic and Value Chain dimensions. The degree of loyalty in a post-merger organization assures the degree of success from the reduction of employee, client and partner turnover.

This Culture Dimension implements the Post Merger Integration Symbiosis Strategy by creating the culture and the environment where all can work effectively, efficiently, fairly and proudly. The degree of success of the Symbiosis Strategy not only makes any downsizing decisions unnecessary but, on the contrary, increases the human resources of the post-merge organization with new roles needed to support, maintain and enhance the success achieved by the existing human resources.

9 The Employee-Culture Fit Model for Post-Merger Corporate Restructuring

The integration of the three dimensions and strategies compose the overall Democratic Employee-Culture Fit (DeECFit) Model visualized for consistency reasons in a six-level pyramid as well (Fig. 6). Each level integrates the activities that take place in the corresponding levels of the DeECFit Dimensions.

The first level of the model emphasizes on the identification of organizational knowledge from human resources. This knowledge can be expressed in the form of innovative ideas voluntarily and openly expressed by each employee or through employee engagement in value chain development challenges. The second level of the model emphasizes on goal-driven teaming and fitting initiatives. Teams are created

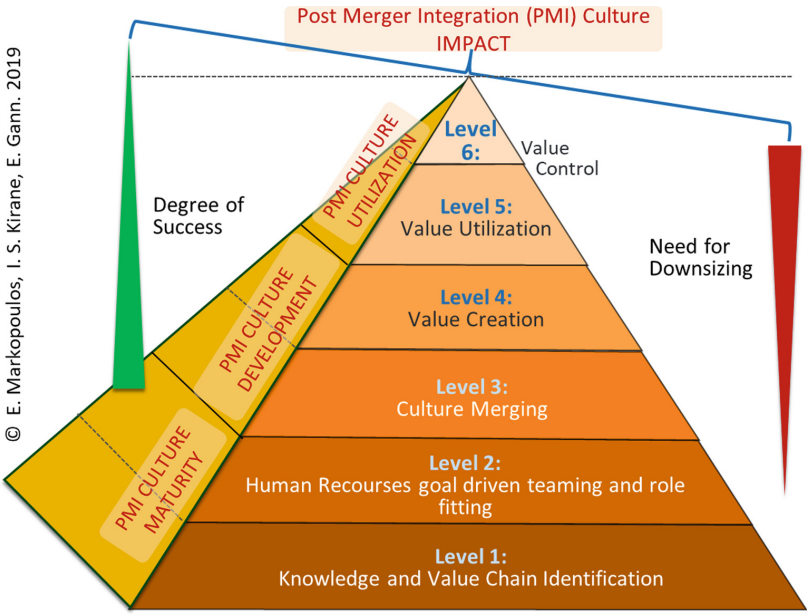

Fig. 6. The DeECFit Model: Key Structure.

around those who seek an opportunity or declare expertise to resolve value chain challenges. The third level emphasizes on merging organizational cultures for the development of the new one. This is impacted by the knowledge identified in level one and the role fitting of level two. The creation of an effective culture can empower the execution of the roles assigned, challenges given, and ideas proposed by the employees. The fourth level emphasizes on the value creation from the execution of the previous levels. This value can be tangible such as competitiveness, innovation, or intangible such as reputation or employee loyalty. The fifth level utilizes the value created in level four through new markers exploitation, internationalization or extroversion. Lastly, level six emphasizes on the impact the merge made in the local and global markets and societies. This impact determines the success of the merge and the number of employees that remain the new organization.

The six levels of the model are categorized into three strategic goals. The first goal category is the maturity the merged organization shall achieve. It is the most challenging goal as this can determine the pace of success and the degree of downsizing. The second category is the development of the post-merger organization culture. This development requires the organizational maturity of the first goal to assure that the human recourses operate under a fair culture and fairly being placed in their roles in order to best perform operations and management. The last category is related to the utilization of the benefits gained from the previous categories. This will determine the impact of the Merger, its sustainability and the ability to reach the synergistic targets.

10 Conclusions

Mergers and acquisitions are often associated with the tragedy or job cuts, layoffs, due to downsizing programs implemented periodically or instantly in order to turn the new organization flexible, manageable and homogeneous.

However, a mind is a terrible thing to waste and human resources are actual minds that generate intellectual capital which cannot be wasted as it is never in excess. The DeECFit model has been developed to protect the people and their jobs while turning the merged organizations into success. The model is based on the principle that if one person can think then all people can think since they have all been created equally. However, some can think more technically, others more creatively and others more sentimentally. In modern organizations, all types of thinking are needed, especially in the ones created from mergers and acquisitions when knowledge plurality is one of the reasons for a Merger to happen. The DeECFit can be used to achieve rightsizing instead of downsizing, by offering equal opportunities for all employees to demonstrate their knowledge, skills, commitment to contribute and desire to stay in the organization.

The three dimensions of the model, each one with a separate evolutionary methodology, and the strategies they form, contribute towards achieving rightsizing. The effectiveness of the execution of the DeECFit dimension reduces the need for downsizing and increase the need for more human resources to handle organizational success (Fig. 7).

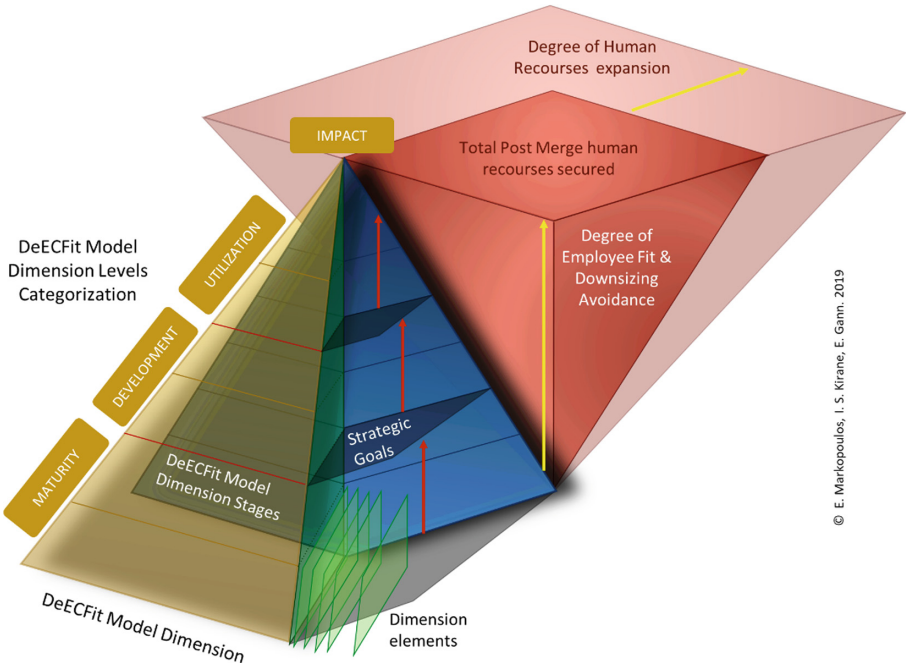

Fig. 7. The DeECFit Model Rightsizing Approach

The DeECFit Model creates jobs during the Integration period when the model is properly executed, meaning that the employees are properly engaged, indicated value and productivity. The lower levels of each dimension are the most complex to execute, therefore the need for downsizing and the risk for many people to lose their work is high. However, once each level is passed successfully this risk is being reduced significantly and can result not only in sustaining all jobs but also expanding to new jobs needed to sustain the effective operations of the newly merged organization.

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Interview Survey Method for Extracting Cultural Trait Applicable to Concept Design

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Abstract. Proposal of interview survey method to extract cultural traits applicable to concept design using disaster prevention a case study.

Keywords: Cultural trait · Interview survey method · Concept design

1 Introduction

In recent years, the number of foreigners entering Japan is expected to increase. However, unlike Japanese people, foreigners have had few disaster experiences. In addition, it is pointed out that their awareness of implementing disaster prevention measures is weak because they have hardly participated in disaster prevention education and are not good at Japanese. Participation of disaster prevention measures and local disaster prevention activities by foreign residents in Japan is an important theme for reducing disaster damage. In disaster-prone Japan, the development of disaster prevention applications is indispensable for disaster prevention measures. In particular, there is a need to develop for users with different cultures. Therefore, it is necessary to design a disaster prevention design that takes into account the cultural traits of users with different cultures.

What are the most important actions to take into account the cultural traits of an affiliate design? The human-centered design process (ISO9241-210) states that "products, systems, and services are designed to take into account the people who use them and the parties affected by their use" [1]. To the statement. It is important how to use the service in order to consider the cultural traits, that is, to clarify the cultural traits of the target user. Therefore, it is necessary to conduct user surveys to clarify the cultural traits of users who have different cultures, and this is a very important role. However, because it is difficult or difficult for designers and developers to spend a lot of time in the research phase, there is a need for a short and efficient user research. Therefore, it is considered that one of the most appropriate methods is the interview survey method that can be obtained efficiently through conversations with the parties.

In this research, when designing an application targeting users with different cultures, it is necessary to extract cultural traits more efficiently in a shorter time. Therefore, cultural traits applied to the concept design for disaster prevention

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applications are considered as examples. The purpose of the present invention is to propose an interview research method for extracting the information.

In proceeding with this research, we will define cultural characteristics. Cultural traits are values that are invisible to people who share or understand the culture, such as the way of thinking, feeling and acting. It can be said that it is worth deciding the way of thinking and behavior of the user [2]. And, it targets the cultural characteristics that each person has in the area of the region, family, and interpersonal relationships. To identify common features and differences when comparing the cultures of two or more countries and regions, and to clarify the cultural characteristics. Cultural characteristics that can be applied to a concept design that provides value to users are values that take into account the commonalities and differences of each country or region.

2 Previous Research

Quensenbery and Szucs "Global UX" book is listed [3]. The Global UX book describes how to think about user experience from a global perspective. In order to clarify cultural traits, it is important to focus on the common points and differences between countries and regions.

One of the interview methods, the cognitive interview, is a method that applies the concept of the investigation interview method developed by the police in England [4]. As a characteristic, the scope of the interviews is not limited to the current situation, but also includes the past, what we have thought from the past, and future expectations and anxiety. In addition, it is possible to listen to a story starting from a time series or "connection" with a person, and to hear that the person is "positioning" in space.

3 Proposed Design Approach

Based on previous research, it was found that cultural traits can be clarified by extracting commonalities and differences between countries and regions. In addition, since the lifestyles and behaviors of users with different cultures are different, common points and differences are extracted from the behaviors and emotions of the users according to the time axis. It is thought that the value can be clarified based on the extracted common points and differences.

In order to extract the cultural traits applicable to the concept design, the interview survey method uses the interview survey method based on the Six Ws (When, Where, Who, What, Why, How) context. The purpose is to extract cultural traits efficiently for users with different cultures in a short time.

Six Ws context-based interviews investigate the time, place, surroundings and user behavior of the events experienced. To make it easier to extract value from past events, we created a "User Survey Sheet" for use in interviews. The specific interview method based on the Six Ws context is as follows.

(1) The theme is the experience you have ever experienced. For example, in the case of disaster prevention application, set "Disaster prevention experience".
(2) Fill in the experiences according to the theme specifically using the user survey sheet. Ask Six Ws to fill out details about who, when, and where.

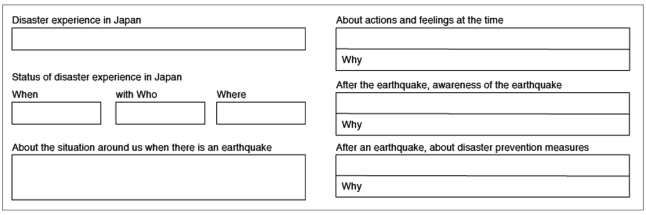
(3) Ask the user survey sheet to fill in the user's actions and feelings based on the time axis and their reasons.
(4) Interview semi-structured based on the contents written on the user survey sheet.
(5) Analyze based on the user survey sheet and interview contents that were filled out, and extract common points and differences. Create a concept based on the extracted common points and differences.

3.1 Experiment for Proposed Design Approach

The purpose of the evaluation experiment is to verify the effectiveness of the interview survey method for extracting cultural traits using interviews based on the context of Six Ws.

In order to verify the proposed interview survey method, we interviewed Japanese and Chinese about disaster prevention experience using a case study of a disaster prevention application. The subjects were five people in their twenties from Japan (subjects: A, B, C, D, E) and five people in their twenties from China (subjects: F, G, H, I, J). Created a user survey sheet based on the user's actions and emotions based on the time axis of "before meeting the disaster", "when there was a disaster", and "after the disaster" of the disaster prevention experience as a case of the disaster prevention application did. Table 1 shows the question items on the user survey sheet.

Table 1. User survey sheet on disaster prevention.



3.2 Result of Evalution Experiment

The purpose of Based on the interview results based on the Six Ws context, the user's intrinsic value was extracted from events. For Japanese and Chinese subjects, the results are summarized for "before the disaster occurred", "when the disaster occurred", and "after the disaster occurred".

Subject A was panicking as people were gathering on the stairs to descend on the first floor when the Great East Japan Earthquake struck. After the disaster, I tried to keep communication clear. Also, I came to worry about the safety around me.

Subject B had shaken furniture and apartments during the earthquake. As an action at that time, I suppressed the TV when it was about to fall. I opened the front door because I was in trouble if I was trapped in the room. As a post-disaster measure, TVs and furniture were re-installed so that they would not fall.

Subject C had his house roof broken and his car swept away. His actions at the time were to first secure water and go to a nearby relative. I wasn't surprised because I got used to the earthquake. We do almost nothing as a post-disaster measure.

Subject D was driving and stopped. At that time, I didn't do anything because I thought it would be safer to sit in the car. I saw that the road was broken, so I knew it was not always safe to be in the car. As a countermeasure after the disaster, the ground has been carefully monitored.

Subject E shakes slowly and falls down, such as a book. The behavior at the time was that I first entered the futon, but the shaking became bigger. Opened doors and windows so that they could not be trapped. After watching the tsunami disaster on TV, I realized that it would be better to go to a higher ground after the earthquake. As a countermeasure after the disaster, the area where we lived became a "planned power outage", so we tried to save power.

Subject F did not stop shaking. As an action at that time, I got under the desk because I had evacuation knowledge that I was taught in Japan. Then he went out to the courtyard and evacuated according to the teacher's instructions. I was notified after the earthquake, so I could not predict the earthquake and thought it was difficult to prepare. As a countermeasure after a disaster, they are always equipped with emergency water and food.

Subject G was warned of the earthquake by a smartphone notification. The water in the glass shook due to a large shake. One of the actions at that time was panic, so I couldn't take action and left the house in a hurry one minute later. This was my first experience of a big earthquake, so I was scared and couldn't do anything. We still have no idea what to do as a post-disaster measure. I want to be with someone for the time being.

Subject H was swaying with a smartphone alarm. The action at that time was to leave the house for personal safety. I investigated the earthquake in detail. I learned that there were collapsed buildings and aftershocks. As a measure after a disaster, keep away from large furniture. Prepared emergency supplies.

Subject I sounded a smartphone alarm. At that time, he fled to the nearest evacuation center as instructed by the announcement. We investigated knowledge and information about disaster prevention. As a countermeasure after the disaster, I did nothing especially as the furniture was not broken or injured.

In Subject J, the windows and the like were shaking. The action at that time was waiting for the earthquake to subside. I'm scared at the beginning of the shaking because I don't know if it's a big earthquake. As a post-disaster measure, we want to escape to a shelter if a large earthquake occurs, so check the shelter.

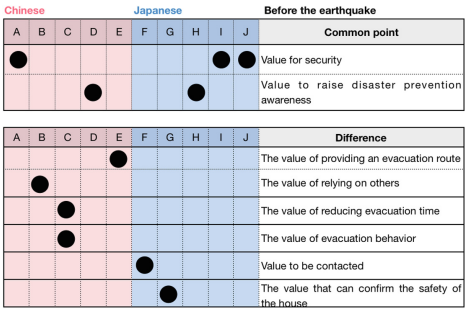
3.3 Consideration of Evolution Experiment

In the evaluation experiments, we used interviews based on the Six Ws context to verify whether cultural traits applicable to concept design could be extracted. Common points and differences were extracted from the results of the "User Survey Sheet on Disaster Prevention Experience" of Japanese and Chinese subjects (Tables 2, 3 and 4).

As a common point between Japanese and Chinese at the time of a disaster, it is strongly recognized that it is important to move to a safe place as soon as possible at the

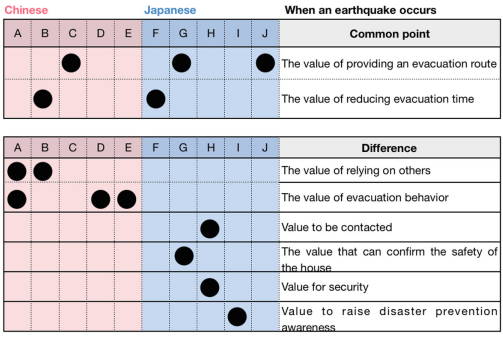
time of a disaster. And "The value of reducing the time required for evacuation". Regarding the differences between the Chinese, it was understood whether the experience of disaster prevention or the importance of getting help from others, such as following an evacuation order from one person, is important. The difference between Japanese and Japanese was that they valued contact with their families and confirmation of their home situation. The Japanese may not be interested in disaster information on a regular basis, but they may be more concerned about evacuation equipment.

Table 2. Analysis sheet of Japanese and Chinese values before the earthquake.



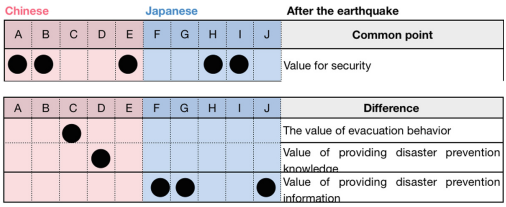
The common points between Japanese and Chinese before a disaster strikes are "value for a sense of security" and "value for improving disaster prevention awareness". During normal times, I realized that disaster prevention measures were to be implemented or needed. As the differences between Chinese people, we extracted the values of "value of providing route information for evacuation", "value of relying on others", "value of reducing evacuation time", and "value of instructing evacuation behavior". It is necessary to provide evacuation drills and information on disaster prevention knowledge to Chinese people in their daily lives. The difference between Japanese and Japanese was that emphasis was placed on contacting the family and checking the status of the house. It is also worth checking the status of the house.

Table 3. Analysis sheet of Japanese and Chinese values at the time of the earthquake.



One of the commonalities between Japanese and Chinese people after a disaster is securing their own personal safety. The difference between Chinese people was the value of providing disaster prevention knowledge according to the evacuation situation, and the need for clear evacuation instructions, or the value of necessity. One of the differences between Japanese people is their knowledge and interest in disaster prevention information.

Table 4. Analysis sheet of Japanese and Chinese values after the earthquake.



4 Conclusion

In this study, when designing for users with different cultures, we believe that it is necessary to first extract cultural traits efficiently in a short time, and to extract cultural traits applicable to concept design. An interview survey method was proposed. To extract cultural traits, an interview survey method based on the Six Ws context was used.

In order to verify the proposed interview survey method, we interviewed Japanese and Chinese about disaster prevention experience using a case study of a disaster prevention application. Based on Six Ws, we conducted user surveys along the time axis of "Before disaster occurred", "When disaster occurred" and "After disaster". As a result, we were able to extract the common points and differences between Japanese and Chinese and clarify their cultural traits, thus demonstrating the effectiveness. However, it was not enough to extract the feelings of the subjects about disaster prevention experience. In the future, it is necessary to extract cultural traits including emotions.

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Design of Human-Centred Technical Systems, Products and Human Capital Development

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Abstract. The article explores the features of the manifestation of the human factor in the development of human-oriented technical and production systems and products, the use of cognitive methods to solve design problems and assess the impact of the design processes of human-oriented technical systems and products on the development of human and social capital. It is proved that the conditions (including the manifestation of the human factor) in which modern advanced manufacturing, technical and production systems are created are determined by the processes of NBIC convergence that have begun and the formation of the new technological paradigm. A method for assessing the growth of human capital based on the information characteristics of the designed systems and products is proposed.

Keywords: Design · Technical systems · Production systems · Human capital · Social capital · Human factor · NBIC convergence

1 Introduction

Under NBIC convergence, human capital is built up significantly more than in traditional technologies and production systems.

The reasons for this are:

1 NBIC technologies are based on the results of basic and search research. Those studies were carried out by highly poor researchers and were the main source of new knowledge.
2 The high complexity of biological, nanoscale and information processes required a high degree of expertise in applied research and technology development.
3 Particular attention paid to cognitive processes that are directly related to human cognitive activity and the generation of new technological and other solutions.
4 The complexity of NBIC technology requires the creation of special equipment from which unique production systems are completed. The design, manufacture and operation of this equipment requires highly skilled workers.
5 Particular attention to the safety of NBIC technologies (in terms of impact on the environment and humans) requires special studies. They are conducted by highly qualified specialists and are additional sources of new knowledge.

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Recognizing the development prospects of NBIC technologies, many researchers [1] point out the risks and threats caused by their wide distribution. These risks and threats are associated mainly with the dangers of exposure to a person, his biological and psychological changes.

Speaking about the focus on the person and the safety of the technical system (product), it is necessary to keep in mind two aspects: failure-free operation (since any accident with a greater or lesser probability causes harm to health and a threat to human life) and environmental well-being, which implies the absence of harm to human health with the stable operation of the created technical system.

At the same time, it is important to develop a methodology for designing production and technical systems that ensures the social and economic interests of society and the state, manifested in the buildup of human and social capital.

2 Methods for Assessing the Value of Human Capital

Considering the impact of NBIC-crnversion and the creation of human-oriented production and technical systems on human capital gains, it is necessary to choose approaches to understanding this term and methods of estimating the value of human capital.

It seems to us the most correct approach to understanding human capital, proposed in the works of Mincer [1], Schultz [2], as well as in studies of the effectiveness of financial and other investments in human capital and the economic approach to human behavior Becker [3, 11].

However, under the conditions of reindustrialization, NBIC convergence, the formation of Industry 4.0 [4, 5]. It is important that this concept is most suitable for cases when human capital acquires significant potential for many production systems, especially high-tech ones.

3 The Information Essence of the Assessment of Human Capital

Obviously, the level of human capital, its changes and assessment are of an informational nature and are directly related to the informational characteristics of the corresponding production systems.

A pragmatic approach to estimating the amount of information is useful in shaping the parameters of a production system [6, 7]. He defines the amount of information as a measure conducive to achieving the goal. This approach is based on the statistical theory of Shannon [8], and the amount of information is considered as an increment in the probability of achieving the goal of the subject's activity. If we take the probability of achieving the goal before receiving information equal to P_0, a and after receiving it P_1, then the pragmatic amount of information $I_{\text{п}}$ is defined as

$$I_{\text{п}} = \log \frac{P_1}{P_{\text{п}}}. \quad (1)$$

In cases where it is necessary to take into account the degree of organization of the reaction of the production system to the effects of the external environment and the internal structural transformations occurring in it, it is advisable to use an algorithmic approach to estimating the amount of information. Academician Kolmogorov in [8] proposed this approach based on the theory of recursive functions. According to this approach, the amount of information of an object is determined by the minimum length of the algorithm, which makes it possible to uniquely transform an object from a less complex to a more complex state.

Any event related to the formation of new information in the production system (new development, modernization measures, rationalization of activities, etc.) should be evaluated by its impact on the resource situation in the system. In this case, the condition "any new information should compensate for part of the costs of materials and energy" must be observed.

Obviously, in this regard, the prevention of a possible loss of information is of particular importance. The whole variety of cases in which such a loss becomes possible, known from practice and described in the literature [13].

To some extent, this can be prevented by mechanisms for assessing the accuracy and reliability of information described in known works [14].

To understand and use information, its recipient must have a specific individual thesaurus Sr, which reflects his knowledge of the subject in question [12]. In this case, the amount of semantic information contained in a message can be estimated by the degree of change of this thesaurus that occurred under the influence of this message. Obviously, the amount of information is I_{c}. non-linearly depends on the state of the user's individual thesaurus, and although the semantic content of the message S is constant, users with different thesauruses will receive an unequal amount of information. If the individual thesaurus of the recipient of information in the field in question is close to zero $S_{\text{п}} \approx 0$, then in this case the number of perceptions of information by him will be equal to zero: $I_{\text{c}} = 0$. This corresponds to a situation where the recipient does not understand the received message. The opposite limiting case is also possible when the individual thesaurus of the recipient $S_{\text{п}} \to \infty$, i.e. he knows everything about the subject in question. In this case, the message also will not give him additional information. Obviously, between these polar values of the thesaurus there is some optimal value, $S_{\text{п опт}}$.

4 The Method of Assessment and Management of Human Capital Based on the Thesaurus

In accordance with Shannon's approach [9], the amount of information was determined as an expression of the diversity of forms of objects that make up the production system for a certain period of time, taking into account the prevalence (static probability) of

various forms of objects in it. However, as Valtukh [9] showed, it is also necessary to take into account the complexity of objects in determining the amount of information.

When a state j, with a relatively high probability propagates due to states with a lower probability, the statement that information degradation takes place is justified: this is true in relation to the real state of things in the system. But if a condition arises that previously (at some point t) did not exist, then its probability will initially be low.

The known formula [9] the dependence of individual information on the statistical prevalence of the object and its complexity:

$$I_i^{P\psi} = \log_2(\psi_i/p_i) = \log_2 \psi_i + \log_2(1/p_i), \tag{2}$$

where $I_i^{P\psi}$ - single information calculated taking into account both static prevalence and complexity of objects i; ψ_i - object complexity indicator i, $\psi_i > 0$. Value ψ_i/p_i expresses the complexity of objects i per unit of probability, which, in turn, is an expression of the relative number of such objects in the system, and Shannon is the value of unit information - $\log_2(1/p_i)$ - appears as an assessment arising under the condition that the complexity of the objects that form all its various states in the system i, the same and therefore can be taken equal to 1.

Information about the production system as a whole appears as the sum of information determined by complexity and information determined by static prevalence. At the same time, not only the less common elements are actually less likely, but those whose very occurrence is possible in fewer ways; with relatively rare combinations of factors; in longer processes, etc.

It is enough to refer to the facts related to technocenosis, consisting of units of technological equipment [10]. Their more complex groups, in fact, arose instead of simple ones under some relatively rare conditions.

These considerations can be summarized in the following recurrent formula:

$$p_\eta = p_1 \prod_{\theta=2}^{\eta} q_\theta = p_{\eta-1} q_\eta, \tag{3}$$

where $\eta = 1, 2, \ldots$; $\theta = 1, 2, \ldots$ - indices of the stages of transition from simple to complex state in some production system; p_η - historically systemic probability of components arising at the stage η, that is, their probability in the history of the development of the production system as a whole (p_η - cumulative value: accumulates during the transition from relatively high to relatively low (by index η) stages of development of the production system; $p_1 = 1$; $q_\theta(q_\eta)$ - intrinsic probability of components arising at the stage θ, that is, the probability of their occurrence in the conditions prevailing at the previous stage $\theta - 1$.

The amount of information embodied in the employees and, as indicated above, which is the criterion of human capital, should be determined taking into account the fact that this resource has a hierarchy of qualification complexity. This can be formally expressed in the concept of qualification categories of labor g, [10].

On this basis, the concept of personnel management can be proposed as a set of carriers of thesaurus information that determines the economic value of the professional

qualities of each employee in a particular production system. At the same time, it is advisable to determine the volume of thesaurus information that an employee of a particular profession and qualification possesses based on the scope of work that he must perform in accordance with corporate standards and the informational complexity of a particular job.

Obviously, in this case, the informational complexity of an individual work should be determined by the number of certain minimum indivisible volumes of information (details) necessary for its implementation. The main difficulty here lies in the systematic presentation of an individual work and the identification of the requisite details. For this, it is necessary to conduct special studies at the intersection of economics, sociology, psychology and physiology of labor and information theory.

5 Conclusion

When developing human-oriented technical and production systems and products in conditions of NBIC convergence, human capital increases significantly, associated with the design and subsequent operation of such production systems and products. This is due to the technological features of the NBIC convergence processes and the peculiarities of the organization of production in these conditions.

In conditions of NBIC convergence, human capital should be understood and evaluated taking into account the effectiveness of financial and other investments in the development of employees and the economic approach to human behavior. However, the most important is the informational approach to assessing human capital based on the professional thesaurus of employees, which develops as they participate in the creation and operation of new production systems.

On this basis, the concept of personnel management was proposed as a set of carriers of thesaurus information, which determines the economic value of the professional qualities of each employee in the production system created on the basis of NBIC technologies.

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A Dual-Axis Force Sensor with Passive Eddy Current Damper for Precision Measurement

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Abstract. This paper presents a novel two-degree-of-freedom (two-DOF) passive damping system dedicated to the vibration suppression of a dual-axis precision force sensor. The damping system consists of two identical eddy current dampers (ECDs), each of which utilizes a double-layer Halbach-array permanent magnet (PM) structure and a middle-layer copper plate to generate a large damping force. Analytical models are established to predict the damping characteristic of the ECD. The finite element simulations are conducted to verify the effectiveness of the analytical models. The simulation results indicate the large damping coefficient of the developed ECD.

Keywords: Force sensor · Eddy current damper · Halbach array · Magnetic flux density

1 Introduction

Multi-axis precision force sensors play more and more important roles in the applications where a high-resolution force measurement is expected in the cases of micro/nano surgery, biological cell manipulation, nanoimprint lithography, optical fiber assembly, etc. [1–3]. All solid-state force sensors are to transmit the acquired deformation of flexible structure by the capacitive, piezoelectric, and piezoresistive methods into the required force signals [4]. High resolution of force sensor means high sensitivity and low noise. To achieve higher sensitivity, the stiffness of flexible structure is required to be much lower, which is easy to cause mechanical vibrations due to the external disturbances.

A lot of research on passive eddy currents for various damping applications, such as braking system of high-speed trains, precision machining, vibration suppression of ultra-precision equipments, and suspension system of automobiles, etc., has been reported in the literature [5–8]. Sodano *et al.* designed an ECD using the radial magnetic flux of PMs to provide the electromagnetic damping force for the vibration suppression of a cantilever beam [9, 10]. Ebrahimi *et al.* analyzed the damping force of the developed tubular ECD with an array of axially magnetized PMs separated by iron pole pieces [11]. Jin *et al.* investigated the effect of ECD on the dynamic vibration

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characteristics of the high-temperature superconducting magnetic levitation, such as vibration amplitude and frequency was investigated [12]. Yip *et al.* introduced an application of eddy current damping effect on single point diamond turning of titanium alloys [13]. Lu *et al.* integrated an ECD into a large TMD instead of conventional viscous fluid damper to suppress the vibration of a five-story steel-frame structure [14]. Fan *et al.* developed an ECD for the vibration suppression of assembly interface machining of large aircraft vertical tail [15]. The experimental results show that the designed ECD can guarantee the stability and reliability of assembly interface machining. Sung *et al.* utilized an ECD to improve the positioning capability of a linear air-bearing motion stage, which has a weakness of low damping due to the non-contact feature of air bearing [16].

The previous research reveals that much attentions have been focused on the one-DOF (i.e., linear or rotary) vibration suppression based on passive ECDs, while having less attentions on two-DOF ECD. The motivation of this paper is to design a novel compact two-DOF ECD with identical and high damping coefficients along the *x*- and *y*-axes to suppress the vibrations of a dual-axis precision force sensor.

2 Force Sensor Description

As shown in Fig. 1, the developed force sensor includes three critical components, i.e., sensor body, four strain gauges for force sensing, and two ECDs. The sensor body adopts a double-loop symmetrical structure, consisting of an outer loop with four flexures A and an inner loop with four flexures B. Both loops are connected in serial at the two intermediate movers linked together through a rigid bar at the rear side of the sensor. To achieve dual resolutions and ranges, the flexure A is constructed with the long and thin beam, while the flexure B with the short and thick beam. Taking the x-axis force for example, under a small external force, the flexure A undergoes a larger deformation due to a smaller stiffness relative to the flexure B. If the same strain gauges are utilized to detect their deformations, the larger deformation means higher output voltage, resulting in higher resolution [1]. Therefore, the strain gauge 1 provides higher resolution for the small-force measurement. Then, as the external force increase, the intermediate mover contacts the stopper A with three-directional limitation as shown in

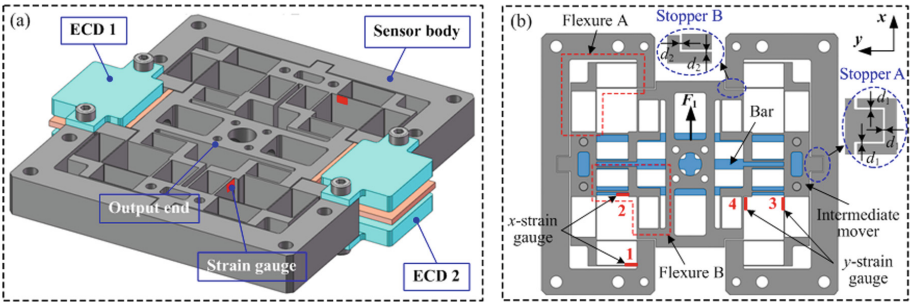

Fig. 1. Dual-axis force sensor. (a) CAD model and (b) sensor body

Fig. 1(b). After that, the deformation of the outer loop remains unchanged, and thus the reading of the strain gauge 1 keeps stable at the maximum value while the strain gauge 2 continues to work with low resolution for the large-force measurement. The range of the small force depends on the clearance d_1 between the intermediate mover and the stopper A, which is restricted by the manufacturing process. Moreover, the stopper B with a clearance d_2 is to protect the force sensor from exceeding the designed maximum force.

To suppress vibration and improve stability and reliability of the force sensor, a novel two-DOF ECD is developed as shown in Fig. 1. It adopts the structure of double-layer PMs and a middle-layer conductor. The PMs of each layer are arranged in Halbach array with continuous and closed magnetic flux path. It reduces the requirement of steel strip on the PM base using light aluminum alloy instead. The major advantage of Halbach array lies in the strongest magnetic flux density (MFD) with the smallest amount of PMs, which enables a more compact structure for limited design space.

3 Eddy Current Damping Model

In the eddy current damping, the stationary magnetic field comes from a double-layer Halbach PM array as shown in Fig. 2. The magnetic surface charge model is utilized to estimate the MFD distribution of the two-DOF ECD, where each individual PM is considered in the modeling. The charge distribution and parameter definition of a single PM is shown in Fig. 2. The charges are uniformly distributed on the two parallel surfaces perpendicular to the PM magnetization direction. The MFD outside the PM due to the magnetic charge surface is expressed as [17].

$$\boldsymbol{B}({}^{L}\boldsymbol{r}) = \left(B_x({}^{L}\boldsymbol{r})\ B_y({}^{L}\boldsymbol{r})\ B_z({}^{L}\boldsymbol{r})\right)^{\mathrm{T}} = \frac{B_r}{4\pi}\sum_{i=0}^{1}\sum_{j=0}^{1}\sum_{k=0}^{1}(-1)^{i+j+k}\begin{pmatrix}\ln(R-T)\\ \ln(R-S)\\ \tan^{-1}(ST/RU)\end{pmatrix} \tag{1}$$

where ${}^{L}\boldsymbol{r}$ is a position vector defined by $(x_0\ y_0\ z_0)^T$ in its local coordinate system. B_r denotes the remanent flux density of the PM, and

$$S = x_0 - (-1)^i a,\ T = y_0 - (-1)^j a,\ U = z_0 - (-1)^k a,\ R = \sqrt{S^2 + T^2 + U^2} \tag{2}$$

To analyze the MFD distribution of the entire ECD, a global coordinate system $O\{x,\ y,\ z\}$ is defined in the geometric center of the PM array. Any position ${}^{L}\boldsymbol{r}$ can be

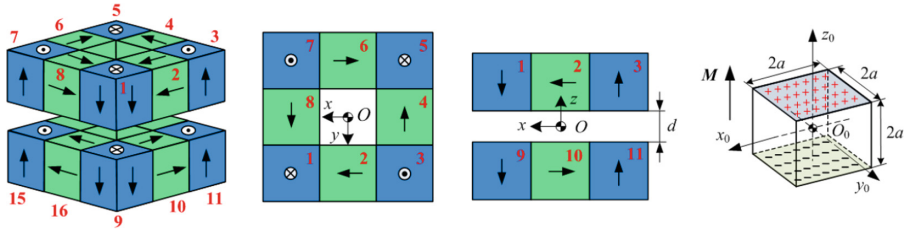

Fig. 2. Halbach PM array of the two-DOF ECD.

transformed into ${}^{G}\boldsymbol{r}$ with respect to the global coordinate system by the following expression as

$$ {}^{G}\boldsymbol{r} = \boldsymbol{R}_m \cdot {}^{L}\boldsymbol{r} + {}^{G}\boldsymbol{P}_m \tag{3} $$

where $\boldsymbol{R}_m$ and ${}^{G}\boldsymbol{P}_m$ presents the rotation matrix and relative position of the local coordinate system m with respect to the global one, respectively.

Consequently, the MFD of a single PM in the global coordinate system is derived as

$$ \boldsymbol{B}_m({}^{G}\boldsymbol{r}) = \boldsymbol{R}_m \cdot \boldsymbol{B}_m\left(\boldsymbol{R}_m^{-1}({}^{G}\boldsymbol{r} - {}^{G}\boldsymbol{P}_m)\right) \tag{4} $$

By applying this transformation to all PMs, and based on the superposition principle, the MFD distribution of the ECD can be written as

$$ \boldsymbol{B}({}^{G}\boldsymbol{r}) = \sum_{m=1}^{16} \boldsymbol{B}_m({}^{G}\boldsymbol{r}) \tag{5} $$

Considering that the conductor thickness is far less than the skin depth at a low speed, the skin effect inside the conductor is not considered in the analytical modeling [18]. Due to the symmetry of the two-DOF ECD, only the damping characteristic along the x-axis is analyzed. The induced eddy current density due to the relative motion between the magnetic field and the conductor is given as

$$ \boldsymbol{J} = \alpha\sigma(\boldsymbol{v} \times \boldsymbol{B}) = \alpha\sigma v_x\left(-{}^{G}B_z\boldsymbol{j} + {}^{G}B_y\boldsymbol{k}\right) \tag{6} $$

where the factor α describes the effects of the surface Coulomb charge and the finite conductor dimension [19], σ denotes the conductive coefficient of the moving conductor, v_x is the conductor velocity along the x-axis, and ${}^{G}B_x$, ${}^{G}B_y$, and ${}^{G}B_z$ represent the components of $\boldsymbol{B}({}^{G}\boldsymbol{r})$ in the x, y, and z directions, respectively.

According to the Lorentz's law, the induced eddy current interacts with the magnetic field, which generates a electromagnetic force as

$$ \boldsymbol{F}_e = 2\int_V\int\int (\boldsymbol{J} \times \boldsymbol{B})dV = 2\alpha\sigma v_x\left[\left(-{}^{G}B_y^2 - {}^{G}B_z^2\right)\boldsymbol{i} + {}^{G}B_x{}^{G}B_y\boldsymbol{j} + {}^{G}B_x{}^{G}B_z\boldsymbol{k}\right]dV \tag{7} $$

where the coefficient "2" represents that the force originates from two ECDs. Therefore, the damping force can be obtained as

$$ \boldsymbol{F}_d = -2\alpha\sigma v_x\boldsymbol{i}\int_V\int\int \left({}^{G}B_y^2 + {}^{G}B_z^2\right)dV \tag{8} $$

It can be seen from Eq. (8) that the damping force is proportional to the conductor velocity, which shows a viscous damping effect. Further, the damping coefficient of the ECD along x- and y-axes is derived as

$$c = 2\alpha\sigma \int\int_V \int \left({}^{G}B_y^2 + {}^{G}B_z^2 \right) dV \tag{9}$$

However, the above linear relationship is only suitable for the case of a low speed. The skin effect will be not negligible, and the MFD induced by the eddy current opposite to the MFD of the PMs will be also taken into account in a high velocity.

4 Finite Element Simulation

Finite element simulations are performed to evaluate the performance of the force sensor. The parameters of the sensor body and ECD are listed in Table 1.

The flux density distribution of the PM array is obtained as shown in Fig. 3. It is seen that the MFDs between the two layers of PMs along the x- or y-axis weaken each other but the MFD along the z-axis is enhanced. The feature can improve eddy current damping and meanwhile can enable the identical damping characteristic in the x and y directions. The influence of PM distance d on the MFD B_z at a constant position (z = 0 and y = 4.8 mm) by the analytical model and FEA are compared in Fig. 4. It is seen that the analytical results coincide with the simulation results, and the MFD shows the characteristic sinusoidal distribution of the Halbach array. The MFD B_z decreases as the distance d increases, and thus a small distance is required for a large MFD.

Table 1. Parameters of the sensor body and ECD

Variable	Value
Dimensions of flexure A ($l_A \times b \times t_A$)	$14 \times 12 \times 0.3$ mm^3
Dimensions of flexure B ($l_B \times b \times t_B$)	$11 \times 12 \times 0.65$ mm^3
Elastic modulus (E)	71.7 GPa
Poisson's ratio (γ)	0.33
Density (ρ)	2810 kg/m^3
Dimensions of the PM ($2a \times 2a \times 2a$)	$4.8 \times 4.8 \times 4.8$ mm^3
Thickness of the conductor (t_0)	1.7 mm
Remanent flux density (B_r)	1.45 T
Permeability of the conductor ()	$4\pi \times 10^{-7}$ H/m
Conductive coefficient of the conductor (σ)	5.8×10^7 S/m

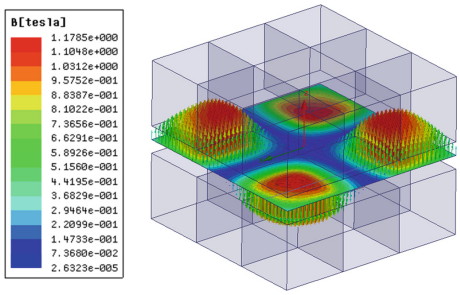

Fig. 3. Flux density distribution of the PM array.

On the other hand, the damping characteristic of the ECD, i.e., the damping force and damping coefficient, is evaluated using Maxwell transient solution. The influence of air-gap thickness on the damping coefficient is shown in Fig. 5, where the damping coefficient decreases nonlinearly with the increase of the air-gap thickness. Although

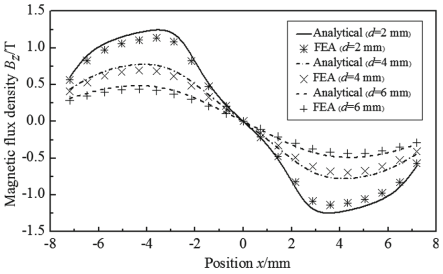

Fig. 4. Influence of PM distance d on B_z.

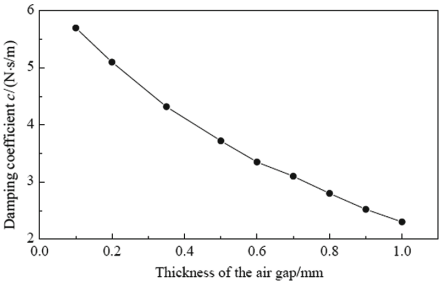

Fig. 5. Air-gap thickness verse damping coefficient.

the smaller the thickness and the larger the coefficient, the thickness cannot be too small due to the limitation of machining and installation error. Moreover, if the structural space of the ECD is not limited, increasing the number and size of Halbach array PMs can also result in a more larger damping coefficient.

5 Conclusion

A novel two-DOF ECD is developed to suppress the translational vibrations in the x and y directions. The ECD adopts the symmetric Halbach PM array with identical damping coefficients along the x- and y-axes. Due to its compact structure, it is suitable to be integrated into the miniature vibrating devices. As an application case, it is utilized to accelerate the vibration decay of a dual-axis force sensor. The analytical eddy current damping models of the developed ECD are established, and then verified by finite element analysis. In the future work, the prototype of the force sensor will be fabricated, and a series of experiments will be conducted to validate the overall performance of the sensor system.

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A Critical Analysis of Music Recommendation Systems and New Perspectives

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Abstract. Many businesses enhance on-line user experience using various recommender systems which have a growing innovation and research interest. Recommender systems in music streaming applications proactively suggest new selections to users by attempting to predict user preferences. While current music recommendation systems help users to efficiently discover fascinating music, challenges remain in this research area. This paper presents a critical analysis of current music recommender systems and proposes a new hybrid recommender system with efficient and enhanced prediction capabilities.

Keywords: Human-Computer Interaction · Music recommender system · User-centered Design · Usability and User Experience · User Customization

1 Introduction

With many music items available on the Internet, the task of finding acceptable and preferred music has become difficult. Music recommendation systems help to solve this problem. They help users to filter from the many items available and discover songs of their choice. Music recommendation systems are much more complex than other recommendation systems due to the following facts [1]:

Duration of the music item - Unlike movies or books where the duration is much longer, a song usually lasts 3 to 5 min which makes it more forgotten.
Vastness of items lists - A music catalogue has millions of songs compared to the number of movies in a movie catalogue. Hence, challenges such as scalability faced in building a music recommendation system are higher than any other type of recommendation system.
Continuous serial access - Unlike movies, music pieces are consumed more frequently in a session. The right arrangement of songs is a challenge.
Recommending similar music items more than once - Users prefer to listen to the same song twice, which is not the case in a movie recommendation system. Thus, the user may prefer the recommendation of a music item more than once.
Listening behavior - Unlike in situations such as watching a movie or reading a book, users do not usually pay attention when listening to a song; it mostly happens

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passively. This paper presents a summary of music recommendation systems with the goal of finding out how it could be improved.

2 Characteristics of Music Recommendation Systems

A music recommendation system mainly has three components; a User, a music item and an algorithm to match users with music items. The first component, User, addresses the variations in users' profiles. Preferences of users change due to many criteria. For instance, the difference in age, profession, gender, interests and many more aspects may cause differences in music preference. User preference variations can be captured using two factors. (1) User's personal profile - that is based on user's demography, psychography, and geography. (2) Music access pattern - defines how often a user listens to music [2]. Based on this information, a user's preferences are considered when designing a music recommendation system. Access patterns can also be used to improve dynamic optimization; to find the optimal recommendations for a user in the end. The second component, which is a music item, defines various information regarding the song. Information regarding a music item can be generated using two sub-factors. (1) Editorial data: metadata of the song (artist, composer, title, alum name, date of release, genre, etc.) (2) Acoustic data: features of the item [2]. The third and final component is the user-item matching algorithm. This generates the link between the users and music items by matching users' preferences with features of music items. In music recommendation systems this is usually done by tracking initial details submitted, listening history, feedback, etc.

3 Approaches in Music Recommendation

There are mainly two ways in which recommendations can be generated: Collaborative Filtering and Content-Based Filtering. The following discussion explains these approaches.

3.1 Collaborative Filtering (CF)

Collaborative Filtering systems are built on the concept that users who rate items alike will continue to do so in the future. It recommends music items through the preferences provided by other similar users. They generate recommendations by considering ratings of music items between similar users. Last.fm is an example of a collaborative system. Thereby it creates a matrix of user-item ratings. This assists in identifying which users rate alike. This utilizes the nearest neighbor algorithm. However, there are advantages and disadvantages of using a user-item matrix. The center of recommendation systems is user data. This data can be obtained in two methods: explicit and implicit feedback.

(a) Explicit feedback: This data can be obtained when the user is taking direct action and that indicates his preference. For instance, one-to-five-star ratings or thumbs-up and thumbs-down feedback.

(b) Implicit feedback: Looking at the user behavior on the application. For instance, play counts can be used to infer an implicit rating.

There are three main subdivisions of Collaborative Filtering: memory-based, model-based, and hybrid collaborative filtering [1].

Memory-based Collaborative Filtering. Memory-based CF provides recommendations based on previous ratings. This is motivated by the observation that users usually trust the recommendations from like-minded neighbors. This became very popular because they are easy-to-implemented, very intuitive, avoid the need for training and tuning many parameters, and the user can easily understand the rationale behind each recommendation [3, 4].

Model-based Collaborative Filtering. This approach uses data mining and machine learning algorithms for the system to train and provide recommendations. User preferences are represented by a set of rating scores and construct special prediction learned complex patterns based on training data [2]. Matrix factorization (MF) is the most popular CF technique used in music streaming platforms. A proven method used in addressing scalability and sparsity is Matrix factorization-based CF algorithms. MF is a linear technique [7]. Alternatives to address limitations of MF are Probabilistic MF and Weighted MF. The three types of Collaborative Filtering techniques have advantages and disadvantages which have been discussed in Table 1. CF methods face certain challenges due to the way and means of its data-gathering methodologies, implementation, design, etc. which have been addressed in Table 2.

Table 1. Comparison of collaborative filtering technique

Collaborative Filtering (CF) Approach	Main advantages	Main shortcomings
Memory-based CF	• Easy implementation • New data can be added easily and incrementally • Need not consider the content of the songs being recommended	• Dependent on human ratings • Performance decrease when data are sparse • Have limited scalability for large datasets • Startup problem prevails
Model-based CF	• Address the sparsity, scalability • Improve prediction performance • Give an intuitive rationale for recommendations	• Expensive model building • Lose important details due to dimensionality reduction techniques
Hybrid recommenders	• Overcome limitations of CF approaches such as sparsity and gray sheep	• Increased complexity • Expensive implementation • Need external information that is usually not available

Table 2. Limitations of collaborative filtering

Limitation	Cause and Explanation
Data Sparsity	Recommender systems are used to evaluate very large item sets. Therefore, the user-item matrix used for collaborative filtering will be extremely sparse
Human Effort	User's effort to rate songs using explicit data [18]. Human effort is needed to fill user preference surveys [12]
Popularity Bias	Songs with higher ratings tend to be recommended more than the less rated songs [12]
Cold start Problem	New songs cannot be recommended until some user rates it, new user isn't likely to get recommendations until his profile is evaluated [5]
Scalability	When the existing number of users and songs grow, CF algorithms suffer from scalability problems [5]

3.2 Content-Based Filtering (CBF)

This approach analyses song tracks to predict user preferences. There are two methods to this; low-level filtering and high-level filtering. Low-level filtering takes a music item's metadata such as artist, album, year of release, genre, etc. as inputs. High-level filtering considers tempo, pitch, loudness, and instruments etc. as inputs.

Challenges of Content-based Filtering. 'Startup problem' is the limitation created by features explicitly associated with the songs recommended [5]. 'Overspecialization problem' recommends items that score highly against a user's profile. This approach relies on the details of the music items thus, the system is limited. This is called the "glass-ceiling effect" [2]. For instance, this approach doesn't have the ability to recognize a rock song with melodic lyrics and a rock song with non-melodic lyrics. Thus, this system may predict screamed lyrics songs to users who prefer melodic lyrics.

3.3 Other Methods in Music Recommendation

Hybrid Filtering. This method of filtering combines the advantages of both CF and CBF and can avoid their individual limitations [14, 15].

Emotion-Based Model. Emotion-based methods use two factors to perceive emotions: how positive or negative, the emotion is and how exciting or calming the emotion is. One challenge is data collection since in order to accurately model the system, a large amount of data is needed [16]. Ambiguity and granularity is a significant issue since emotion itself is hard to define and describe [17].

Context-Based Model. This approach uses public opinion and information to collect details regarding music items such as genre, artist, etc. in providing recommendations. Challenge in Emotion-Based Model is 'Popularity Bias'.

4 Proposed Recommendation System

4.1 Dynamic Playlist Generation

The proposed system will address three main components. First component is Dynamic Playlist Generation. Users are often required to remember or search through an entire collection of media items to locate a song. When the collection of media grows, the required effort also increases. Generating and recommending a playlist for users is a great method to deal with this issue [8, 9]. There are several techniques:

(a) Neighborhood Recommendations - KNN approaches with binary cosine similarities between playlists provide sufficiently accurate recommendations.
   I. KNN + Sequential patterns
   II. Bayesian Personalized Ranking (BPR)
   III. Content-based approach (using metadata of songs) with KNN.

(b) Content-based Approaches - Using content information of tracks (metadata) may lead to the successful tackling of the cold-start problem of CF methods and add diversity and novelty to recommendations [8].

4.2 Next-Track Recommendation

Next-track Recommendation is a specific form of music recommendation that relies mainly on the user's recently played tracks to create a list of tracks to be played next [10]. A particular challenge in this context is that the recommended tracks should not only match the general taste of the listener but should also match the characteristics of the most recently played tracks [6]. Session-based approaches [13] are a good way to predict the user's immediate next actions [5, 6].

4.3 Automatic Playlist Continuation

Automatic Playlist Continuation is more challenging and newest research area in the Music Streaming industry. The basic concept is to give a user a playlist containing some seed tracks, thereafter a list of tracks should be recommended for continuing the playlist. Selected method is hybrid session-based recommendations [11].

5 Future Research

This research is also developing an App, 'HelaBeat', for Android devices. User preferences are captured at first installation through the beta-version available on the Google Play Store. Further analysis and research will be undertaken to incorporate recommendations and new music fingerprinting and identification system within the same app.

6 Conclusion

This paper presents a survey of state-of-the-art music recommendation systems, and a proposed hybrid recommendation system that will perform better than other published methods. The outcome of the complete research work, including the full implementation of the new proposed approach within the Hela-beat app, will provide users with seamless streaming of songs and more effective recommendations.

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The Ergonomic Evaluations of Three Front Baby Carriers: Mother's Perspective

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Abstract. This paper evaluates the physiological and psychophysical response of mothers carrying their own baby using three different front baby carriers. Eleven mothers (aged 28–37 years) with their own baby (weight: 9.18 ± 2.1 kg) participated in this study. Maximum right shoulder pressure was measured before walking. The electromyography (EMG) and skin temperature of the shoulder and abdomen area were measured during walking. Immediately after walking, the Borg's rating scale of perceived exertion was used to collect discomfort ratings at various body parts. The results were similar in all response factors to our previous study, which used a convenient sample of women and dummy doll. However, with further comparison, mothers showed significantly lower EMG activities and all Borg's scales, but higher temperatures apply in both shoulder and abdomen areas. In conclusion, Type A, B and C carrier performed similar in either mother or women, but in mothers the effect was smaller in most responses.

Keywords: Baby carrier · Electromyography (EMG) · Skin temperature · Borg's scale

1 Introduction

Baby carrier or baby sling for carrying infant or toddler is often more practical and convenient than pushing a stroller—especially during hiking, traveling, or running errands. Carrying baby in the front has been promoted by World Health Organization [1]. Rey and Martinez first introduced Kangaroo mother care (KMC) and was initially designed to care low birth weight (LBW) infants. It is skin-to-skin contact between the baby and the holding person and is similar to marsupial caregiving, [2] and would enhance the mother-baby attachment [3]. While caregiver's responses to carrying a baby in the front had been evaluated, mother's responses of carrying their own baby are still undiscovered. Using the front carrier compared to the traditional baby sling has found to have higher muscle activities of paraspinal muscles [4]. Wu et al. [5] evaluated both men and women using three different front worn baby carriers including a baby

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sling while walking with a dummy doll. They found that the baby sling had similar responses in EMG activities to the two front worn baby carriers. In shoulder pressure measures, the baby sling also performed similarly to the padded shoulder straps. The skin temperature results showed that padded shoulder straps did increase skin temperature and females had higher skin temperature than males in abdomen area. The EMG results showed males used more upper back muscles whereas females used more belly muscles when carrying a baby in the front. Although, these results have given the reader a great deal of information in terms of choosing a baby sling or front worn harnessed baby carrier. It would be interesting to see what would the physiological and psychophysical responses for mothers while carrying their own child using these three different baby carriers. Thus, the purpose of current study was to evaluate mother's responses in terms of EMG, skin temperature, heart rate and perceived exertion while using different front baby carriers.

2 Methods

2.1 Subjects

Eleven mothers (age 31.3 ± 2.8 years old, height 160.8 ± 6.5 cm, weight 60.5 ± 11.2 kg) with their own baby (weight 9.18 ± 2.09 kg) were recruited. The inclusion criteria were: 1. no current musculoskeletal pain or pathology; 2. no any systemic disease. Each subject was asked to sign an informed consent form approved by the Institutional Review Board of the MacKay Memorial Hospital after informed about the purpose and procedure of the study.

2.2 Study Design

This study was a single factor design. The independent variable was the three baby carriers. The dependent variables included peak shoulder pressure, surface electromyography, skin temperature, heart rate, and the perceived exertion using Borg CR10 scales.

2.3 Instrumentation

Surface Electromyography (SEMG) and Skin Temperature. NeXus 10 (Mind Media Inc., Netherlands) is an 8-channel wireless device and used to measure SEMG and skin temperature. The SEMG of upper trapezius, rectus abdominis, and erector spinae were recorded using Ag/AgCl adhesive disposable surface electrodes. The BIOMED II recommendations of the European Union was used for electrode placement for each muscle group and the maximum voluntary contraction (MVC) testing procedure. The EMG activities (sampling rate of 2048 Hz with low-pass filtering at 500 Hz and high-pass filtering at 20 Hz) during carrying were calculated by using the formula [6] and were expressed in % standardized EA (sEA).

Skin temperature of the upper back and abdomen were collected using two thermistors which were attached 1. between mid-point between C7 and the acromion for

the upper back probe and 2. 3 cm above the belly button for the abdomen probe. The sensor was reported to measure the change within 1/1000 of a degree.

Body Pressure Distribution. A flexible pressure sensor sheet (CONFORMat®, Tekscan, Inc., USA) was used for shoulder peak pressure. The CONFORMat® was a 53.92 × 61.84 cm^2 sheet (sensor matrix: 471.4 × 471.4 cm^2) with 1024 pressure sensors embedded between the soft fabrics.

Heart Rate. Heart rate was recorded using a heart rate monitor (RS800CX, Polar Electro, Finland). The heart rate monitor (H3 heart rate sensor, Polar, USA) was attached to a strap tied onto the subject's chest, transmitting data to a watch on the subject's wrist. During carrying activities, the heart rate monitor was used to record the subject's heart rate and ensure the subject's heart rate did not exceed 75% of their maximum heart rate (220-age). The exercise intensity was also calculated using the Karvonen equation [7].

Perceived Exertion. The Borg rating of perceived exertion scale (Borg CR10) [8] was used to collect the subjective discomfort feeling in 7 different body regions, including: neck, right shoulder, left shoulder, upper back, mid-back, low back, and abdomen.

Baby Carriers. Three commercially popular front baby carriers were selected for evaluation. Each baby carrier claimed to be comfortable to wear and had its unique design described as fallow: baby carrier A is a carrier using mesh fabric with 2-part designed; baby carrier B uses padded shoulder straps and waist-belt; baby carrier C is a cotton ring sling.

2.4 Study Protocol

Two researchers conducted the experiment and each had different jobs during the protocol. The two investigators standardized the wearing methods for the three baby carriers prior to the experiment. After each subject's body height and weight were recorded, the EMG electrodes, skin temperature probes and the heart rate sensor were then attached. Resting EMG and heart rate were collected for three minutes followed by measuring the maximum voluntary contraction for the three muscle groups. The order of using the three baby carriers was randomized. The baby carrying mothers carried their baby and walked at a comfortable speed for 20 min. A 10-min rest was given between each experiment combination.

2.5 Data Analysis

Analysis of variance was performed to evaluate the effect of baby carriers on the response measures. Duncan's multiple range tests were conducted as a post-hoc testing. Statistical analyses were performed using the statistical analysis software SPSS v.20.

3 Results

SEMG and Skin Temperature. The effects of baby carriers on EMG of the three muscles and skin temperatures in upper back and abdomen are summarized in Table 1. The EMGs in all three muscles were found to have no significant differences while using the three baby carriers. For skin temperature, significantly higher upper back temperature was found in baby carrier B.

Table 1. The mean and standard deviation of SEMG and skin temperature.

Muscles	Baby carriers			Sig.
	A	B	C	
Upper trapezius	2.28 ± 1.04	3.70 ± 1.97	4.78 ± 3.23	
Erector spinae	10.06 ± 4.59	9.47 ± 5.69	11.52 ± 3.67	
Rectus abdominis	1.78 ± 1.52	1.44 ± 1.29	1.63 ± 1.49	
Skin temperature				
Upper back	34.24 ± 0.58[b]	35.2 ± 0.62[a]	33.99 ± 0.52[b]	***
Abdomen	35.46 ± 1.09	36.29 ± 0.98	35.97 ± 1.09	

Note: Data are given as mean ± SD %MVC for EMG and mean ± SD °C for skin temperature.
a, b: Duncan grouping code
* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$

Body Pressure Distribution. The baby carrier B revealed significantly smaller in peak shoulder pressure (Table 2).

Heart Rate and Exercise Intensity. The average heart rate and exercise intensity during walking showed in Table 2. There were no significant influences on heart rate and exercise intensity.

Table 2. The mean and standard deviation of peak shoulder pressure, heart rate, and exercise intensity.

Items	Baby carriers			Sig.
	A	B	C	
Peak shoulder pressure	2.97 ± 1.05[b]	1.68 ± 0.67[a]	2.87 ± 0.71[b]	***
Heart rate	86.21 ± 8.27	85.61 ± 7.78	85.86 ± 6.31	
Exercise intensity	14.91 ± 4.40	14.3 ± 4.80	14.51 ± 4.62	

Note: Data are given as mean ± SD kPa for pressure, mean ± SD bpm for heart rate; mean ± SD % for exercise intensity
a, b: Duncan grouping code
*** $P < 0.001$

Perceived Exertion. The results of subjective rating using Borg CR10 are listed in Table 3. Baby carrier B showed significantly lower perceived exertion in both shoulders and upper back areas.

Table 3. The means and Duncan groupings of Borg CR10 scale

Areas	Baby carriers			Sig.
	A	B	C	
Neck	1.41 ± 1.59	0.36 ± 0.64	1.36 ± 1.29	
Left shoulder	2.14 ± 0.75[b]	0.86 ± 0.92[a]	0.91 ± 0.83[a]	*
Right shoulder	2.82 ± 2.16[b]	0.64 ± 0.64[a]	3.55 ± 2.46[b]	**
Upper back	1.27 ± 2.04[a]	0.45 ± 0.42[a]	3.32 ± 3.08[b]	*
Mid-back	0.77 ± 0.85	0.86 ± 1.45	2.18 ± 2.40	
Low back	1.82 ± 2.31	2.14 ± 1.70	1.73 ± 1.89	
Abdomen	0.59 ± 0.77	0.86 ± 1.21	0.95 ± 1.19	

* $P < 0.05$, ** $P < 0.01$

a, b: Duncan grouping code

4 Discussion and Conclusion

In current data, three baby carriers showed significant differences in both objective and subjective data in shoulder-upper back areas. EMG data did not show significant differences among the three baby carriers. It is different from the report of Wu et al. [5], that higher upper trapezius activities in baby carrier B, and the sling carrier (baby carrier C) did perform similar to either front-worn harnessed carrier. When we compared previous data of female subjects who were not mother, it is interesting to find the inexperienced subject's EMG activities were significantly higher in both erector spinae and rectus abdominis. This same trend could be found in exercise intensity. In our survey, among the 11 mothers, four of them used baby carriers similar to baby carrier B and four of them used baby carriers similar to baby carrier C, others did not use any baby carrier. Further, mothers may carry their baby for longer than 20 min, which may explain why perceived exertions (Borg's scale) were smaller than the previous study [9]. Skin temperature in shoulder area showed higher in type B carrier. This result was similar to previous study [5], however, in current study, mothers had higher skin temperature in both shoulder and abdomen areas. The fact that carrying real baby could potentially increase skin temperature was observed. In conclusion, Type A, B and C carrier performed similar in either mother or woman, but for mothers the effects were smaller in most responses.

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Artificial Intelligence and Computing

Designing Trust in Artificial Intelligence: A Comparative Study Among Specifications, Principles and Levels of Control

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Abstract. This paper presents a comparative study amongst the three main frameworks acknowledged for designing trust in AI; specifications, principles and the levels of control necessary to underpin trust in order to address the rising concerns of Highly Automated Systems (HAS). We will also address trust design in four case studies specifically designed to address the rising concerns of these systems in the area of health and wellbeing. Based on the results, levels of control emerge as at the most reliable option to design trust in Highly Automated Systems, as it provides a more structured focus than specifications and principles. However, principles enhance philosophical inquiry to frame the intended outcome and specifications provide a constructive space for product development. In this context, the authors recommend the integration of all the frameworks into a multi-dimensional cross-disciplinary framework to build and extend robustness throughout the entire interactive lifecycle in the development of future applications.

Keywords: Human factors · Human-systems integration · Specifications · Levels of control · Principles · Trust · Virtual assistants

1 Introduction

Artificial intelligence (AI) systems are increasingly being used to replace human decision-making. While AI holds the promise of delivering valuable insights and knowledge across a multitude of applications, broad adoption of AI systems will rely heavily on the ability to trust their output.

With the exponential development of machine learning (ML) and deep learning (DL) techniques, a new paradigm is emerging; Machine-Human-Interaction (MHI). In this emerging paradigm, the technology holds the initiative of the interaction. These developments have urged Peter Hancock to raise a concern to the human factors community by which attention must be focused on the appropriate design of a new class of technology: Highly Autonomous Systems (HAS) [1]. This approach positions highly autonomous systems at the centre and tries to address the implications of trust from their perspective [2].

As we progress in the development of AI, the idea of 'performance' as an AI design paradigm will not be enough. Questions around, how do we achieve fairness,

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robustness, explainability, accountability and value alignment through design, and how do we integrate them throughout the entire interactive lifecycle, are fundamental for the development of trusted HAS. In this context, we must learn how to build, and monitor trust.

For the last forty years, human factors approached the design of complex autonomous systems by articulating Levels of control as a design strategy to appropriately calibrate trust to achieve performance and safety goals [3]. However, Principles have recently become a design strategy being proposed from social and ethical perspectives to address trust [4]. Finally, Specifications are being proposed from a computational perspective as a design strategy to address the rising concerns of highly automated systems [2].

This paper will present a comparative study among the aforementioned frameworks to understand which of the three frameworks is better suited to design trust in the context of HAS. It will do so by addressing trust design in four case studies specifically designed to address the rising concerns of these systems in the area of health and wellbeing. In this regard, a workshop has been conducted with Design Research students at the [Removed for Review]. The workshop was structured over two days around the four case studies aforementioned.

In this context, we structured a workshop with seven students from the Masters of research programs (MRes) at the Royal College of Art. They represented a multiplicity of backgrounds ranging between fashion, textile, architecture, computer science, industrial design, and engineering.

2 Method

According to Bukhari [5] a Comparative Study analyses and compares two or more objects or ideas to examine, compare and contrast them to show how two or more subjects are similar or different. Building from this perspective we built a comparative study among the three main frameworks acknowledged to design trust in AI; specifications, principles and levels of control in order to underpin which one is better prepared to address the rising concerns of highly automated systems. In this context we aimed for a mixed methodology combining constructive approaches in the form of a design workshops, experimental design to control the variables and a semi-structured questionnaire and a post-activity debate synthesis to evaluate the outputs.

In order to address the task at hand, we defined the main area of intervention; health and wellbeing. Then, we structured four exercises around systems capable of diagnosing and providing treatment in the areas of anxiety, obesity, depression and addiction. The lead author introduced a video-demonstration of Duplex to illustrate the nature of the system and a small analysis that underlined the key characteristics of upcoming Virtual assistants. The students had 50 min to complete each task, which consisted of four parts;

1. A mapping exercise to underpin potential interventions
2. Introduction of a design framework.
3. Inference exercise to define four data points and four algorithms. This was designed to encourage students to define datasets and inference algorithms. The main purpose was to bring sensitive areas into the equation to trigger ethical design interventions.

4. An interaction task consisting of a user journey and potential design intervention. This part was structured in three areas; before the interaction, during the interaction, and after the interaction.

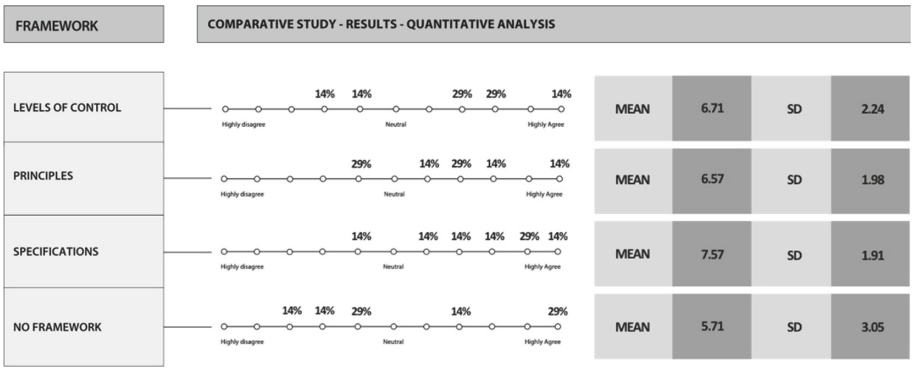
The first exercise introduced no framework. It operated as a control mechanism to understand what the students were bringing to the table and whether they would implement ethical interventions. The second exercise introduced specifications. The third exercise incorporated principles. And the last exercise introduced levels of control. In the latest exercise, a multi-dimensional framework was presented in collaboration with a trust calculator to facilitate participants' output definition by inserting a mode of calculation by which a trust rating could be obtained.

Once all the exercises were completed, the lead author introduced a semi-structured questionnaire to understand which framework was better suited to design trust in Highly Automated Systems. The questionnaire consisted of two areas; a quantitative area asked participants to rate the four frameworks proposed; no framework, principles, specifications and levels, by using an eleven points Likert scale, and a qualitative area asking participants to define the pros and cons of each framework.

3 Discussion

In the quantitative area, Specifications emerge as the most favoured framework by participants rating it with 7.57 in mean value. It is followed by levels of control with 6.71 and no framework with 6.57. The least favoured framework was Principles with 5.71 mean value (Table 1).

Table 1. Quantitative analysis



When reviewing the qualitative data obtained by asking participants to describe the pros and cons of each framework, they praise specifications for its semistructured nature which provides them with a flexible-constrained space for intervention. This differs from the prescriptive nature of levels, the openness of no framework and the abstraction of principles.

However, they also point to the limitations of specifications to address trust in ever-evolving systems, as it is a one-time a priori intervention which does not allow for a posteriori rectification. It is described as a powerful tool to understand user needs but limited to design trusted systems, especially in the context of HAS, with unsupervised and ever-evolving capabilities.

In this context, levels are described as a tool to implement quick adjustments, are beneficial, and enhance distributed self-optimisation to maintain control over the system. Furthermore, when integrating the calculator into the levels and providing a form of calculation participants described this combination as useful in reducing risks, integrating a critical dimension in product development and enhancing explainability in the design process [6].

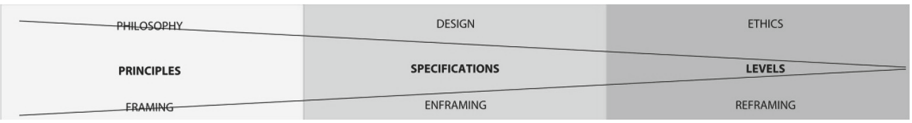
Principles though are seen as a philosophical element to open relevant debates. Finally, no framework is described as open, yet too loose in focus and abstract to address the rising concerns presented (Table 2).

Table 2. Qualitative analysis and Post-activity debate synthesis.

PARTICIPANT	COMPARATIVE STUDY - RESULTS - QUALITATIVE ANALYSIS			
	LEVELS	PRINCIPLES	SPECIFICATIONS	NO FRAMEWORK
PARTICIPANT 1	A trust calculator helped for quick design adjustments.	Provide perspectives	Helps you understand the key specifications you must focus. but you may forget to adjust it post-design	More organic and less restrictive But you can get lost.
PARTICIPANT 2	System learning from personal and collected data but user may not follow the system	System learning from personal and collected data but user may not follow the system	System learning from personal and collected data but user may not follow the system	System learning from personal and collected data but user may not follow the system
PARTICIPANT 3	Helps to categorise the ideas	Too abstract	Too abstract	More open answers, opportunity to be more fluid/free with design
PARTICIPANT 4	Strong control gives users confidence but leaves less space for the service system to process the outcome.	Relevant. they matter	Relevant. they matter	can be more based on the users
PARTICIPANT 5	interesting	Very fun	hard to understand at the begining	May be
PARTICIPANT 6	Beneficial	Philosophical	Pro: understanding the user needs, Con: lacks breakdown of effects of trust intervention.	without framework difficult to break down. Too abstract and open
PARTICIPANT 7	Distributed self-optimisation	Open debate	not like in the industry	Difficult

DEBATE	COMPARATIVE STUDY - RESULTS - FINAL ANALYSIS			
	LEVELS	PRINCIPLES	SPECIFICATIONS	NO FRAMEWORK
PARTICIPANTS	Closed system. Too prescriptive	Too abstract	Semi-structured. opens but does not close	Too open

These outputs are significant because they match a recent paper published on the 10th of November, 2019 by the Oxford Institute of the Internet in *Nature* claiming that principles are not enough to design trusted AI systems [7]. In this context, instead of providing a categorical excluding output, we propose to build an integrative multi-dimensional design framework by acknowledging the key beneficial elements of the three main frameworks by distributing these paradigms over time.



4 Conclusion

Based on these results, Levels of control emerge as at the most reliable option to design trust in Highly Automated Systems, as it provides a more structured focus than specifications and principles. However, principles enhance philosophical inquiry to frame the intended outcome, and specifications provide a constructive space for product development. In this context, the authors recommend a combinatorial strategy where principles are used as a preliminary element to frame the intended outcome. The use of specifications follows by determining the interaction and the use of levels is used as a strategy to calibrate interactions to build trust within the system to address a priori strategies around simulation, meanwhile strategies around calibration systems a posteriori strategies around reparation. The integration of all the frameworks into a multi-dimensional framework aims to build and extend robustness throughout the entire interactive lifecycle in the development of future applications.

This paper presents leading insights by providing a comparative study among proposed frameworks to design trust in AI. Although limited in scale, the results provide a highly relevant contribution to knowledge, as no other study we identified has compared these elements at once. In the process, it provides knowledge for future actions via a categorisation of existing frameworks and the development of an integrative cross-disciplinary framework to address the rising concerns of trust in AI. Future work will be dedicated to further evaluating the reliability of the frameworks presented.

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Solving the Revolving Door Problem: Machine Learning for Readmission Risk Assessment

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Abstract. In 2012 the United States passed legislation, penalizing hospitals for readmission of patients discharged within 30 days. However, many unknowns mean that hospitals cannot predict when each patient is appropriate to discharge. Through researching readmissions across the Thomas Jefferson University Hospital enterprise, we found that staff must make judgement calls based on their own clinical perspectives. Rather than expecting doctors to somehow intuit the interaction effects from thousands of variables, we surface trends and present strategies for mitigating readmission risks through machine learning (ML). Commonly, ML models are trained against data aggregated from various sources. This method of sourcing interferes with responding to population-based risk factors and variables that are specific to the hospital of interest. However, creating a custom model presents its own set of hurdles. The work of our team provides hospitals everywhere with an end-to-end pipeline to create a readmissions assessment tool, using their own data.

Keywords: Machine learning · Readmissions · Healthcare · Reduction · HRRP

1 Introduction

When a hospital discharges a patient, the expectation on both sides is that the patient has healed sufficiently to no longer require hospital care. Unfortunately, this assumption is proven wrong all too often. In 2012, the United States government passed a law, penalizing hospitals when patients that they discharged in the last 30 days are readmitted. This policy discourages the poor practice of suboptimal discharges through a financial disincentive. However, many unknowns mean that hospitals are not well-equipped to predict when any given patient is appropriate to discharge. On average, a single readmission costs a hospital $14,400, 15% more than the cost of care for the same patient's index admission. In 2011, the cost of readmissions nationwide totaled $41.3 billion. However, a 2016 study by Auerbach et al. categorized 26.9% of readmissions as preventable, representing a potential for over $11.1 billion in savings annually. Of course, to capture these savings, hospitals need to know which patients are at risk for readmission, and why.

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The factors contributing to a higher risk of readmission are diverse and include a wide range of variables. Although these variables have been identified, a study conducted in 2011 by Allaudeen et al. determined that medical providers were unable to accurately predict which patients were at the highest rate of readmissions, indicating a need for a risk assessment tool.

Two widely used prediction models are the LACE index and HOSPITAL score. The LACE index uses four variables to predict the risk of death or non-elective 30-day readmission after hospital discharge among both medical and surgical patients. This model was originally validated using data on 4,812 patients discharged from 11 community hospitals in Ontario, then again using administrative data collected randomly from 1,000,000 discharges also in Ontario; the LACE index has inconsistent results in studies conducted outside Ontario [1]. In the original study, LACE was moderately discriminative for 30-day unplanned readmission with a C statistic of 0.679 (95% CI 0.650–0.708) [2].

The HOSPITAL score uses seven readily available clinical predictors to identify patients at high risk of potentially avoidable hospital readmission within 30 days. This score has been internationally validated in a population of over 100,000 patients at large academic medical centers (average size of 975 beds) and has been shown to have superior discriminative ability as compared to other prediction tools. In the study above, the HOSPITAL score had a C statistic of 0.72 (95% CI, 0.72–0.72), showing good discrimination. This study noted several limitations. The model focuses on a medical population, and it may not be generalizable to other patient populations such as surgical patients [3]. Additional predictors could likely have been used to improve the model's discrimination. We address these shortcomings in accuracy, generalizability, and specificity with a machine learning (ML) model.

ML refers to a subset of computer science in which programs learn and improve from the data provided to them. We aim to apply modern computational techniques to ingesting, analyzing, and predicting readmissions to improve patient safety and hospital efficiency. In this paper, we will discuss a method of generating hospital-specific readmission predictions, prediction risk descriptors, as well as address some of the difficulties and potential optimizations for our model platform.

2 Methods

Through qualitative and quantitative research, we found that staff, as expected, make judgement calls based on their clinical perspectives. While medically appropriate approach, we believe that data-driven guidance can help providers do even better. Rather than expecting doctors to intuit the interaction effects from thousands of variables, we surface trends, quantifying, contextualizing, and presenting strategies for mitigating readmission risks through machine learning.

Determining the type of model to use greatly depends on the shape and content of the data provided. Since our training data is labeled (we know whether or not a patient was readmitted within 30 days), a supervised learning model is appropriate. In supervised learning, we ask the model to determine whether new cases belong to a category that we have previously demarcated and on which we have provided data. Following this determination, the decision of whether to treat patient data and readmissions as continuous or discrete values. This choice would determine whether to use classification or regression-based models. Readmission timing exists as a continuous variable, however, whether or not a readmission occurs is binary. Similarly, many patient health variables are distributed along a continuum, but may be categorized into discrete chunks. Due to our primary outcome measure being binary, we chose to use a classification-based system.

Throughout the patient lifecycle both in and out of the hospital, many metrics are accumulated. We next needed to determine which of these patient metrics best predict if a patient will return to the hospital within 30 days. These metrics range from social determinants (e.g. zip code), to demographic data (e.g. age), to clinical data (e.g. ICD10 code). Adding too many variables to our model can cause bias in predictions. Bias is introduced when the model is significantly affected by features that are not meaningfully predictive but weigh into the model's determinations.

The following two concepts help us minimize bias. First, we determine the amount of uncertainty in making a prediction given a specific set of features. Then, with the introduction of a feature, we determine how much this uncertainty has been reduced. If we determine that the uncertainty is not reduced by a significant margin, or increases, then we have determined that this feature should not be included in our model. If the opposite is true, and the addition of a feature significantly reduces uncertainty, we include it as features to predict readmission. Comparing the relative rates of error in training and cross-validation data, and the true and false positive rates as compared to F1 scores were useful diagnostics in the fine-tuning of our model.

3 Results

Using a customized algorithm based on 185,650 patient records, we have achieved an accuracy of 75.8% in the prediction of whether or not a patient will be readmitted. Current shortcomings of this model include relatively high precision but lower recall, shown in Fig. 1 below, resulting in a peak F1 score of 0.42. Patients are much less likely to readmit, and this probability distribution needs to be addressed by our model.

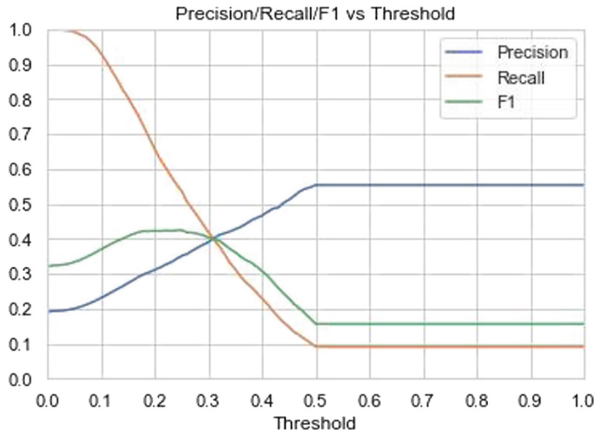

Fig. 1. Precision and recall vs. threshold

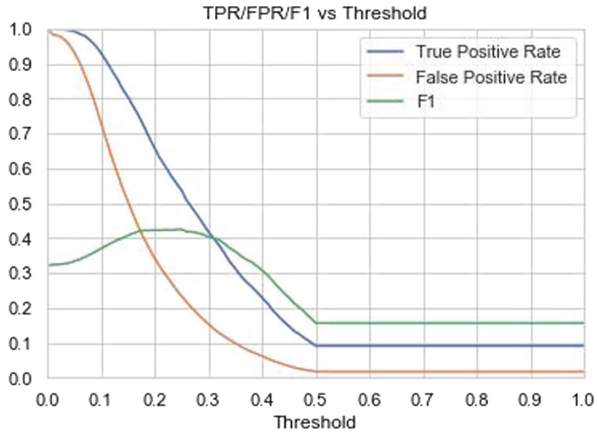

Fig. 2. TP and FP vs. threshold

As shown in Fig. 2, the true positive rate and false positive rate are low for a threshold of 0.5, resulting in an F1 score of 0.17. A threshold of 0.5 is ideal for a dataset with a relatively normal distribution. However, due to the inherent skewness of a readmission dataset, the threshold likely needs to be changed. To mitigate the skewed nature of our dataset, the score threshold was lowered to an optimal point on the recall/precision curve. Put more simply, we are more likely to erroneously predict that someone will not readmit than that they will. The question of toward which side we should err, if we must, will be considered in the Discussion.

A commonly used metric to evaluate the performance of a classification model is AUC, area under the curve, more specifically, the area under a receiving operating characteristic (ROC) curve. ROC curves are used to show the trade-off between the true positive rate and the false positive rate. From the ROC curve, shown in Fig. 3, we

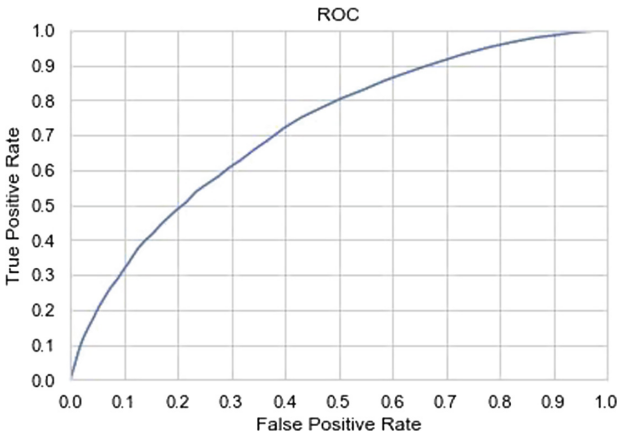

Fig. 3. ROC curve, relating true positive and false positive rates

calculated the AUC value for the model to be 0.73, which is considered fairly good. An AUC value of 0.5 means the model has no separation capacity, and an AUC value of 1.0 means that the separation capacity of the model is excellent.

We expect to be able to improve this score further, given the early stage of work on the model developed. Some ways to improve the model include selecting features that predict readmission with more specificity and sensitivity, applying higher weights to correct readmission predictions to account for the skewness of the data, and tailoring our algorithm choice to be better suited to skewed-data classification.

4 Discussion

Although there are tools available to healthcare providers that allow them to utilize machine learning when assessing the likelihood of a patient to be readmitted, this prediction is normally made against a pre-trained model. These models are trained against data that is aggregated from a variety of different sources and rarely updated. Importantly, these datasets seldom learn directly from the organizations where they are being used to inform predictions. This method of sourcing fails to respond to population-based risk factors and variables that are specific to the hospital of interest [4]. These risks vary not only from one hospital to the other but also across departments within one institution [5, 6]. Current readmission prediction tools fail to stratify and identify the intersecting variables that define the population at risk. Our research takes into account these specific variables to help provide a more granular approach to this problem and provide caregivers with a set of causative factors to determine appropriate interventions. Having this targeted approach helps to prevent skewing of hospital resources as well as ensures any patients with a higher risk score are not missed. We pulled regularly collected data from EHR's, allowing this tool to be scalable across many institutions and departments [7].

Current shortcomings of this model include relatively high precision but lower recall, resulting in an F1 score of .42. Our model is more likely to erroneously predict that someone will not readmit than that they will. However, having an over-sensitive model that will have more false positives is safer for patient outcomes. Creating a custom model presents its own set of hurdles, including cleaning the data, training the models, and fine-tuning for optimal results. Normally predictive modeling requires a team of skilled data scientists and a robust technology infrastructure, both common barriers that hospitals are unable to overcome as of now. Tying into this concept, the readmit risk tool needs to be seamlessly integrated into providers' and caregivers' workflows to prevent defaulting to older techniques of intuitive decision making with respect to readmissions. We aim to close these gaps by providing a data-driven and automated tool to interpret and inform readmission decisions.

Another possible hurdle is the idea that predicting readmission does not always equal a prevented readmission, even for a model with high accuracy, it is not enough to present a readmit risk score [8]. Causative factors and possibly best practice advice should be displayed to help steer interventions. We believe this issue can be resolved by working closely with providers to determine appropriate department-specific interventions to address individual readmit risks. Identifying potentially preventable readmissions is a challenge faced across all hospitals [9]. The historical data of patients who were identified as readmits but successfully prevented from readmitting is not recorded in the EHR, making it difficult to train our model accounting for these factors. Going forward, collecting data on readmissions as compared to predictions via our tool will close the gap on this portion of the equation.

5 Conclusion

The work of our team provides hospitals everywhere with an end-to-end pipeline to create a readmissions assessment tool, using their own data. The process begins by transforming raw data into an ingestible dataset. This dataset is then used to train and validate a custom model, which is made available to reduce readmissions across the hospital, as appropriate. By providing hospitals with the means to easily and affordably implement custom machine learning models, we aim to reduce readmissions across the country, to improve patient care, and limit waste.

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Can a Machine Be Intelligent? The New Concept of Intelligent Machine

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Abstract. The article deals with current problems of IT and sets up a new view of semantic memory as a base for artificial intelligence system. The explanation of object defined as a language, not as a data, leads to linked semantic objects and memory sizing paradox.

Keywords: Disruptive technology · Human attitude · Big data · Knowledge filter · Knowledge database · Impact of IT deployment · Primary and secondary memory

1 Introduction

The idea of man-made beings with artificial intelligence (AI) appeared as early as in time of ancient Greece, when Homer's Iliad tells us about machines that are made by the Greek god Hephaistos. Some of these machines being formed human-like, some of them just as machines. At about the same time, the Chinese were telling tales of human-like machines that could think [1]. The prohibited idea to take on the creative privileges of divinities[1] and create an artificial human, although being diabolized for some time in human history, did not stop human thinking of such a creature. The storytellers describe creatures as Mary Shelley's Frankenstein, Karel Čapek's R.U.R.[2] or Jewish Golem[3].

As a start of modern approach to science of AI can be called year 1956, when term "Artificial Intelligence" had been coined by John McCarthy of Dartmouth College to distinguish his work from the influence of the cyberneticist Norbert Wiener [2]. By the middle of the 1960's, strong support in US rise of optimistic wave about the future of art of AI. Progress slowed in 1974 and later when both the U.S. and British governments cut off exploratory research in AI. The cycles of disappointment followed by enthusiasm continuing in the decades until big corporation uses their marketing power

[1] See Second Commandement: "Thou shalt not take the name of the Lord thy God in vain".

[2] R.U.R – is abbreviation from "Rossum's Universal Robots", main actor in Capek's science fiction play dated 1920.

[3] The Golem is a human-revived statue in Jewish mysticism. The idea of figure created by man and revived by him to fulfill his assigned task is, however, much older (literally documented in a short story from the second half of the sixth century BC).

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and put AI back to the market[4]. Unfortunately, since that time, by AI is called any application, which can widely interact with the user and be user friendly. Until now, the scientists are hesitating with the conclusion what the AI could or couldn't be called.

2 Human Intelligence vs. Artificial Intelligence

The study of "mechanical" or "formal" reasoning led directly to Alan Turing's theory of computation. Turing's test of machine intelligence, reflecting the naivety of that time, is obsolete and the question where is the limit when machine could behave "intelligently" is on the agenda. As mentioned above, the AI is now called any friendly interacting application, any self-learning application able to replay memorized chess strategies, any simple application translating one language to another language or converting spoken language to written text. Even the most powerful engine would not be able to translate artistic novel or poem to other language or convert spoken noised speech to correct text file.

To search for the definition of the term "intelligence" in human sense we will end with number of definitions, some of them contradicting, some of them rather peculiar. Theories behind the definition are raising from the trait theories of intelligence[5] through general theories of thinking to information processing theories of intelligence. Trends to copy brain structure into computer hardware and software leads to neural networks development. But whether these programs actually functioned the way brains do was beside the point: it was simply different way of programming.

Nevertheless, the brain structure would be interesting point to start with AI, forgetting the unsuccessful experiments trying to push the brain structure to data/instruction model structure. Critics of the computer metaphor for human thought have often pointed to the discrepancy between the serial – digital "Von Neumann" computer, and the parallel – analog nature of much human thought. Cognitive psychologists countered that it was often impossible to distinguish between a serial model, in which one stage of processing follows on the heels of another, and a parallel model for the same task, in which all processes start at the same time, running in parallel, but finish at different times [3].

Even though we have more than 50 different definitions of human intelligence, we can use a short description of intelligence as a *mental quality that consists of the abilities to learn from experience, adapt to new situations, understand and handle abstract concepts, and use knowledge to manipulate one's environment*. All these qualities, especially **ability of abstraction**, describe the intelligence.

Contrary to this simple definition, we have many approaches to the AI starting from the earliest expert systems, through fuzzy logic and neural network to modern design of contextual AI, robotic AI or quantum AI. The pressure to get as much information from

[4] Number of projects that use AI Google increased from a "sporadic usage" in 2012 to more than 2,700 projects in 2015.

[5] E.g. the theory of fluid and crystallized abilities and many others.

the data we are collecting, often without any obvious usage, push scientist to new approaches to AI. But nevertheless we still remain in old data/instruction model.

3 Data as a Language

In the real life, we do not store an information as a number or text string. What we are storing is representative (description) of the object covering not only its qualities but also relevant semantic information – relation of the stored information to the environment. One extensive step had been done by Bjorn Gruenwald in his Hilbert Engine [4], where all information gathered is conveyed as single whole number entity, shaped as vectors and tensors, giving the information spatial affiliation. The Hilbert Engine changes relational data into a multidimensional coordinate framework[6], which empowers new abilities in searching, sorting and querying information.

Nevertheless, even such an approach is dealing again with "data structure" not an "information structure". As mentioned above, the information is **descriptive entity** which has its own qualities and semantic meaning. Using the semantic net, we can give a sense of ground for building an intelligent system with abstraction ability, which creates a substantial part of the intelligence as described above.

The semantic net, developed by Quillian and others [5], was invented as an explicitly psychological model of human associative memory. A net consists of nodes representing objects, concepts and events, and links between the nodes, representing their interrelations. Consider, for example, the simple net created by descriptive entity and links, as shown in Fig. 1.

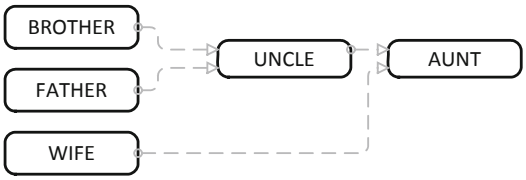

Fig. 1. Linked entities in semantic memory model

In this figure, the object *UNCLE* is created using linked knowledge of *BROTHER* and *FATHER*. All these entities are objects which are defined not only by description its existence, but also by its relationship with the environment and its behavior. They are **described dynamically by language not statically by the data**. This is major difference which has unbelievable impact on the memory size and on the way how the information is stored. Let's analyze the diagram on the Fig. 2.

The "*X*" axis on the picture shows amount of stored information while "*Y*" axis displays the amount of information needed for storing of new knowledge. Both axis

[6] This kind of space is called the Hilbert Space, so that is why it is called Hilbert's Engine.

contain relative values, because knowledge in semantical meaning cannot be expressed in bits or bytes. The amount of information needed to express basic knowledge is high and counted from zero up. The amount of information needed to express derived knowledge, based on previously stored knowledge, is difference between originally stored knowledge and new knowledge. This mechanism has a surprising paradox – more knowledge you are going to store less amount of memory you need.

As an example we can use our linking described in Fig. 1:

- approx. 7.7 units are needed to store a knowledge who "*FATHER*" is,
- approx. 10.5 units are needed to store a knowledge who "*BROTHER*" is,
- approx. 12 units are needed to store a knowledge who "*WIFE*" is.

To define who is the "*UNCLE*", we need just two links to previous knowledge – "*BROTHER*" and "*FATHER*", and similarly two links to define who "*AUNT*" is. Paradoxically more knowledge is known, less amount of memory is used to store new knowledge.

The way of storing of the knowledge here is similar to the way of storing knowledge in the human brain. We would propose that amount of knowledge stored in human brain is based on the amount of "connectivity" not on the amount of "storage elements"[7]. The connectivity of human brain was studied deeply in [6], where size of 10^7 km of wires will be achieved if we compare it to regular wiring. Some other authors came to the different sizes[8], but even thou, the size of the connectivity is enormous. If we start with our estimation of existence of 22.10^9 neurons and each neuron having approximately 2350 connections [6] we can come to the extremely high number of possible combination of connections. In the concordance with previous design of "semantic memory", the amount of knowledge possibly stored, will be related to number of possible connections in the human brain, which goes behind the reasonable limits[9]. More, every connection has "analog" character, this means that the value presented to the input of newly created object – knowledge, will have value, which is not just binary value[10]. The term "semantic memory[11]" related to human refers to general world knowledge that we have accumulated throughout our lives. This general knowledge (facts, ideas, meaning and concepts) is intertwined with experience and dependent on culture[12].

[7] Dividing the neuron space by standard neuron volume produces estimate of 22 billion neurons. Other estimates are 10 billions [10], 13 billions [10] or 20 billions [10], but well below the often cited figure of 100 billion [7].

[8] See e.g. Churchland and Sejnowski figure of 100,000 km of wiring [7].

[9] Actually, the number of possible connection can be computed using Stirling formula to approximately ten to the power of five thousand billions.

[10] The neuroscientist disagrees if this value is clearly analog or coded analog, like e.g. number of pulses per given time etc.

[11] We slightly differ with our understanding of term of "semantic memory" from Minsky definition.

[12] Semantic memory is distinct from episodic memory, which is our memory of experiences and specific events that occur during our lives, from which we can recreate at any given points.

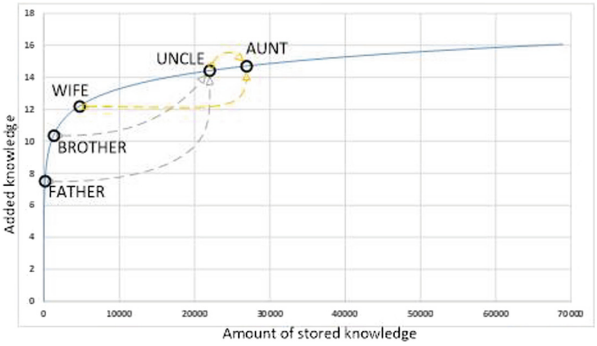

Fig. 2. Semantic memory paradox

4 Conclusions

We have shown elementary model of semantic memory as a basic part of artificial intelligence machine. The mechanics of storing of the information – knowledge in the semantic memory, based on definition of objects not as a data but as a linked language objects, allows the operation similar to human brain. Paradoxically the more knowledge is stored in the semantic memory by linking, less memory is needed or added. With the ability of back linking, formation of the process of abstraction would be possible. Nevertheless, to achieve one hundredth of linking density similar to human brain seem to be impossible even using the best current high tech. We should conclude that the time of achieving at least some partial artificial intelligence with capabilities of human intelligence is far away and we shall stay on the level of self-learning programs for some time.

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Simplified Indoor Localization Data Acquisition by Use of Recurrent LSTM Networks on Sequential Geomagnetic Vectors

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Abstract. In order for indoor positioning services to be able to assert themselves across a broad front, simple processes with minimal costs and low user resistance are preferable. This is where our contribution kicks in: We present a method to detect individual positions within buildings by the use of locally induced distortions of the earth's magnetic field with a smartphone alone, without any additional technology to locate the 2D position. To compensate for the lack of exact 2D coordinates, we fuse the sensor data into a gravitational magnetic vector (GMV) and perform a temporal classification based on a recurrent network. In this work we investigate the applicability of Long-Short-Term-Memory (LSTM) networks to find cross-correlations over a time frame. The trained models are available in a smartphone application. With this application the recognition rates of the locations are analyzed.

Keywords: Indoor localization · Deep learning · Smartphone application · Neural networks · Magnetic fingerprinting · Systems engineering

1 Introduction

In order to support change management towards further provision of basic indoor positioning data, simple processes with minimal costs and low user resistance are preferable. Due to the unavailability of satellite-based systems, other methods must be used to reliably determine the location within buildings. The use of external infrastructure such as beacons or pulse width modulated individual lighting [1–3] requires investments in technical infrastructure. Without external technologies, hot candidates are RSSI fingerprinting, magnetic fingerprinting, dead reckoning and image recognition. The earth's magnetic field is always available, even in an emergency. The sensors consume little energy and are cost-free.

The magnetic field of the earth is inhomogeneous. Anomalies are caused on a large scale by the thermal structure of the Earth's lithosphere. On the level of buildings, these are again superimposed by construction structures. These local distortions within buildings can be recorded and retrieved later. The magic of retrievability takes place in the algorithms.

Previous works have mapped the geomagnetic fingerprints of interiors using robots to create a magnetic 2D map [4, 5]. Such a method imposes a obstacle for most normal users because of the effort required for mapping [6, 7].

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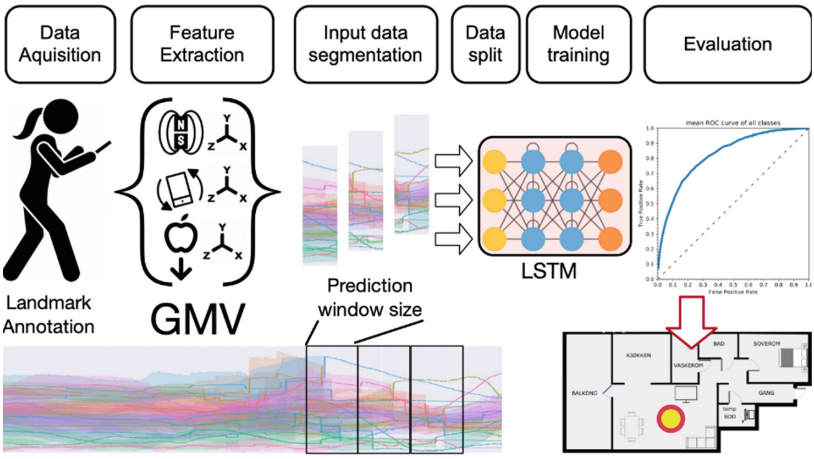

Fig. 1. Workflow overview

Our simplified method is easy to use for the majority of normal smartphone users. On the downside, the increased simplicity for the users drastically reduces the level of information. A sufficiently accurate acquisition of horizontal coordinates is not possible in this way.

We solve this problem by fusion of the sensor data into a multidimensional field formed by a time-varying gravitational vector and a (distorted) geomagnetic vector. Furthermore, we perform a classification of this multidimensional field on the basis of recurrent deep neural networks (Fig. 1). For this purpose, we analyze the applicability of Long-Short-Term-Memory (LSTM) networks on this vector field to find cross-correlations over a variable time frame. The trained models are available in a smartphone application. With this application the recognition rates of the locations are analyzed.

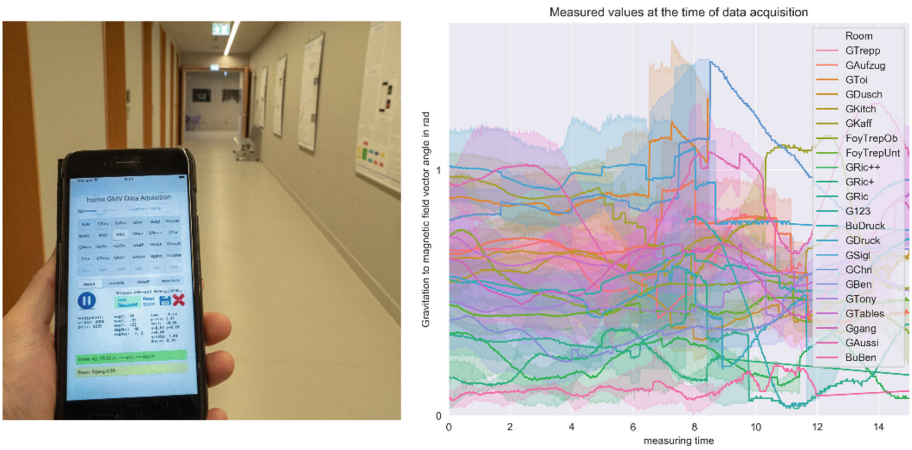

Fig. 2. Recorded data: unfiltered time series of a walk

2 Methods

We avoid the need for exact 2D coordinates to increase usability. Users should be able to map buildings easily and without obstacles.

The goal is to find distinctive landmarks in the building. For this purpose, a smartphone application was created, as shown in Figs. 2 and 3. The sampling rate and experiment are set in the upper range. Below is a button array for fast setting of the landmarks. Landmarks usually mean rooms, but you can specify any location you want. The application provides an import of landmark lists, which is distributed to the buttons after the import. The direction of movement is also recorded. This is not yet evaluated in this paper, but is already available in the already recorded data in this way.

The magnetic field is assumed to be almost fixed at the time of data recording. The user is what moves. First, the coordinate systems of the sensors installed in the smartphone are rotated into the outer world. This is achieved by a rotation matrix provided by the smartphone. This matrix corrects the location-based declination of the magnetic field based on worldwide declination data in conjunction with the inertial sensors of the smartphone as shown in Fig. 3.

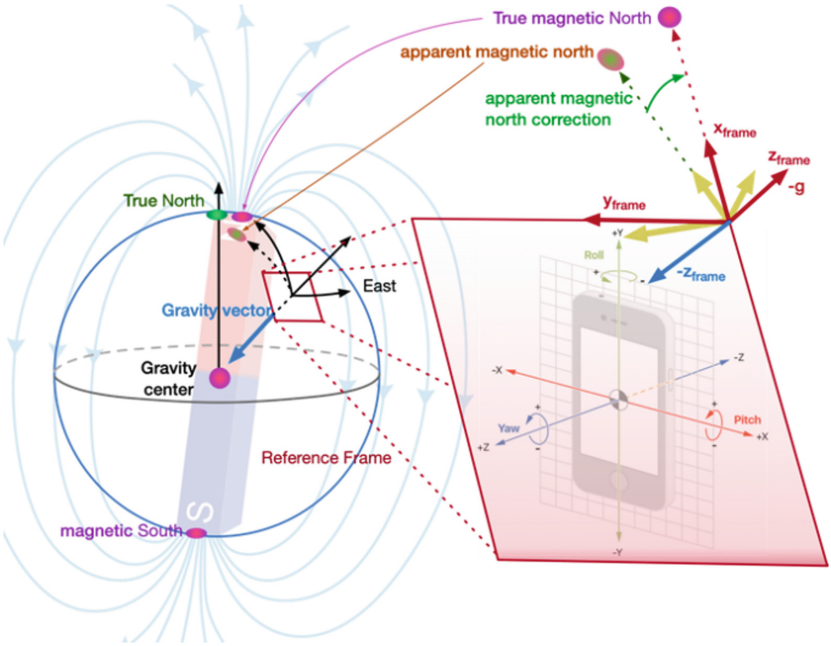

Fig. 3. Data acquisition with smartphone application, reference systems

After coordinate rotation, the magnetic field intensity is available in the x- (right smartphone side), y- and z-direction (out of the display). The position vector of the gravitation points to the mass center of the earth. In order to detect local anomalies of

the magnetic field, a resulting vector is calculated from the magnetic field vector and the gravitational vector. The angle and magnitude of this vector are independent of the orientation of the smartphone in space.

Because of the microanomalies of the earth's magnetic field, the resulting gravitational magnetic vector ("GMV") is variable in position. During the data acquisition the user is moving. In the best case he walks the landmarks continuously, keeps the recording running and switches the landmark by pressing the buttons. By walking all landmarks several times at different speeds, on different sides of the corridor or turning with the smartphone in the hand, user-typical movement patterns are captured.

Any passing or typical behavior near a landmark is divided into sessions. The sessions each contain several hundred to thousands of gravitational magnetic vectors with their temporal sequence. Figure 4 shows some randomly selected landmarks with their GMV.

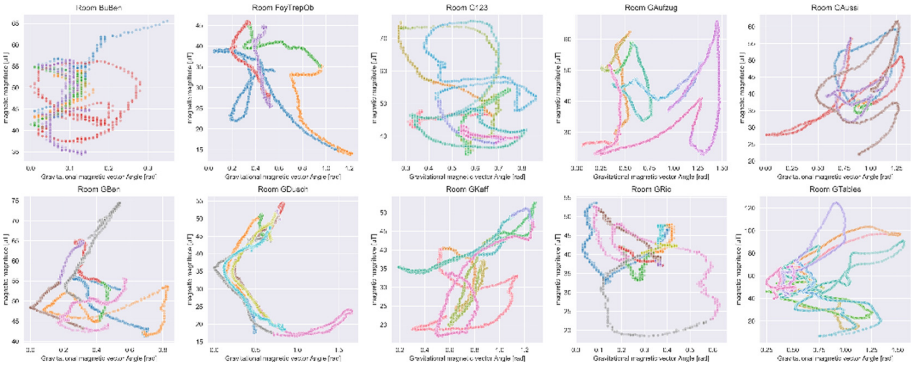

Fig. 4. Temporal GMV of some landmarks. Sessions highlighted in color

The extracted sessions are used to train various recurrent Turicreate activity classifiers. These create a deep learning model that maps temporal characteristics in sensor data to corresponding probabilities. The annotated landmarks represent the output values. The typical GMV time fingerprints form the input values.

Many models were trained to identify useful parameters of the activity classifier. At the beginning of the training, the data were randomly split based on the session id such that one split contains all data for a fraction of the sessions while the second split contains all data for the rest of the sessions. The part containing the training sessions was used to train one model per run. The number of iterations and the width of the relevant time window were varied in order to evaluate the spectrum of possible parameters.

During the training, the models were continuously validated on the basis of the test data. The training phase ended with the creation of 27 models. For all models virtual test runs were performed. The data that had been split off before the training and were not used for training were now supplied as test data to evaluate the models. Each of the 27 models was analyzed with 410 test sessions.

3 Results

Figure 5 shows the ROC curves of the models. First, each of the models is better than a random choice. The models could be trained up to a mean average precision (mAP) of 0.85 in the training data.

This value was reached with a prediction window size (PWS) of 20 samples at all iteration values. The ROC curve in Fig. 5 on the right shows a better result for models with small PWS. The influence of the iteration depth is smaller than that of the PWS. Even with a value of only 100 iterations, the model with a PWS of 10 samples is the winner in the recognition rate with an AUC of 0.92. The best model shows in Fig. 6 a True Positive Rate of 90% with a False Detection Rate of 30%.

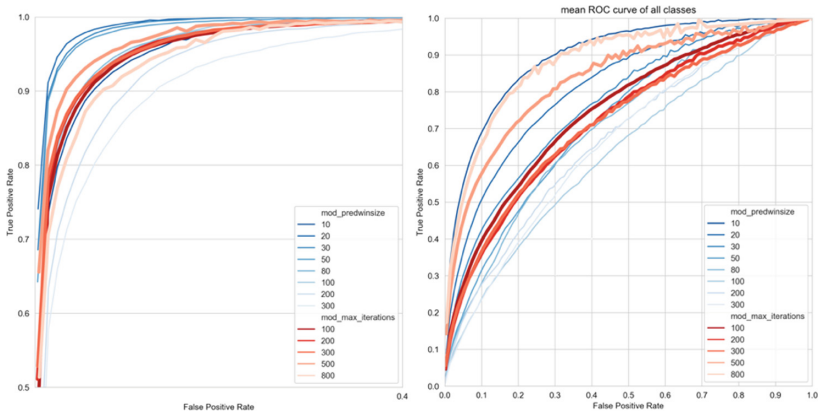

Fig. 5. Receiver-Operating-Characteristic-Curve (ROC-Curve) over training dataset (left) and test dataset (right) with different prediction window sizes and iterations.

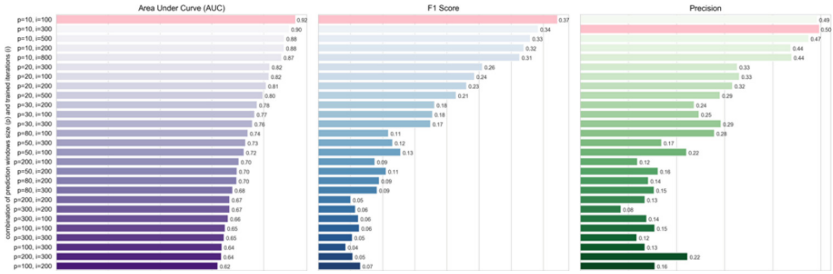

Fig. 6. Characteristic values of trained models

4 Discussion and Future Work

The models with small PWS with values of 10 and 20 samples consistently show the highest mAP. However, the mAP is still unsatisfactory with 0.5.

The activity classifier triggers over time. The low mAP at this point is probably caused by too little training data. It is possible that the user's movement pattern is different in the evaluation than in the data acquisition of the training data. Due to the deviation, not the exact target is recognized, but the target which is located beside the annotated target.

The user will tolerate it if the room beside him is recognized instead of the room in front of him. With the current evaluation algorithm, the scores are only calculated on the basis of the exact true positives. A true positive is only taken if the target is hit exactly. For the purpose of indoor positioning we will implement a validation algorithm in the future which evaluates adjacent targets as "partially correct". For this purpose, the TP rating will be migrated from binary representation to continuous representation. In this way, the validation algorithm is harmonised with the user's feeling of validity.

Furthermore, the number of training data must be increased in order to map all movement patterns in the models.

5 Conclusion

In this first investigation, the detection rates were already able to reach practically usable dimensions, since the targets were often detected spatially directly next to the annotated target.

The majority of users can only be sustainably motivated to equip their buildings with magnetic retrieval data through simplicity of use [8]. Our system offers - compared to previous work with 2D pre-position data - increased user-friendliness for fast and uncomplicated data acquisition when capturing relevant landmarks within buildings. At the moment, this goes hand in hand with lower detection rates of locations and rooms.

Overall, the idea of the recognition of time varying, orientation independent movement patterns with the help of recurrent neural networks offers many approaches for further work.

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Study on Software Log Anomaly Detection System with Unsupervised Learning Algorithm

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Abstract. In recent years, the existence of open source software (OSS) is indispensable for software development. While developer can benefit from functions of OSS, there is a problem that it is very difficult to locate the cause when problems occur. In this study, we propose a method to calculate anomaly score for each line of log data. In our method, the temporal pattern is learned using Hierarchical Temporal Memory, which is an unsupervised real-time learning algorithm, and the anomaly score is obtained based on the internal state of the model. In the experiment, we compare the learning situation in the following three input formats, word ID, word embedding, and sentence embedding. In the experiments using actual log data, it was found that the method with word ID has the highest f1 score and runtime performance, but the precision needs to be improved in order to suppress useless information.

Keywords: Anomaly detection · Hierarchical Temporal Memory · Log · Unsupervised learning · Open source software

1 Introduction

These days, a huge scale of programs has been created in the software development at manufacturers because of the diversification of product functions. Thus, more and more companies are trying to speed up software development by using open source software. While developer can benefit from various functions of OSS, they must deal with a large number of defects caused by inappropriate use and modification of OSS. The speed and accuracy of the analysis depends greatly on the skill level of the analyst, and it is extremely difficult for an inexperienced engineer to analyze data that is a mixture of various software logs.

Therefore, we propose a method to automatically detect and display anomaly parts from the software output log in order to realize a GUI tool that supports defect analysis team. Since it is difficult to prepare a large amount of log data in which the cause is actually annotated, it is desirable to detect anomalies using unsupervised learning. In this paper, we will consider a detection method using Hierarchical Temporal Memory (HTM) [1] which has less computational load.

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2 Proposed Method

In our proposed method, log data output from software is processed in streaming format. The HTM model accepts one log line as input for one step, and learns the characteristics of that line and predicts the next line at the same time (online prediction). The HTM keeps the predicted value of the next input as its internal state, and a decoder is required to make it understandable. Actually, we only want to know the anomaly score of the certain line of input log, so there is no problem if we can know even the internal state of the model. The temporal anomaly score of the current input line are calculated based on the internal state of the model, and the lines where the `anomaly` score exceeds the threshold are marked as candidate cause of the defect (Fig. 1). The details of the HTM algorithm and how to calculate anomaly scores are described in Sect. 2.1.

In the proposed method, any conversion method can be used as long as one line of log can be converted into some scalar or vector value. In this paper, anomaly scores are calculated in three input formats: word ID, word distributed representation, and sentence distributed representation. Regardless of the input method, the log message is first broken down into tokens by the WordPiece [2] tokenizer. In the case of word input, each one of these tokens is the input of one step to the HTM model and the average value of the anomaly scores for all tokens in a line is recorded as the anomaly score for that line. When using the distributed representation, the outputs of the last layer when these tokens are input to BERT [3] are acquired as the word distributed representation. When using the sentence distributed representation, the sum of embedding of all tokens contained in one line is input to the HTM as a distributed representation of the line. The WordPiece tokenizer and general-purpose language model BERT are described in detail in Sect. 2.2.

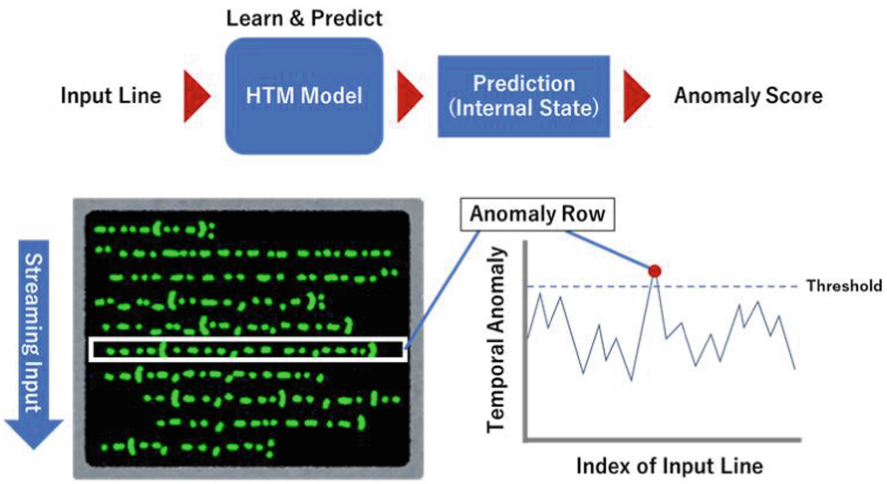

Fig. 1. Outline of proposed method.

2.1 Hierarchical Temporal Memory

Hierarchical Temporal Memory (HTM) is the method proposed by Jeff Howkins et al., which reproduces the information processing mechanism in the neocortex. The HTM assumes that the input value is an array consisting of 0 or 1, that is, a binary vector. Therefore, in order for HTM to understand your data, you need to implement an encoder that converts the data values into binary vectors. Any conversion method can be used as long as the converted value is a binary array.

Binary vectors are first entered into a layer called Spatial Pooler (SP). SP consists of units called columns, and each column is connected to a partial area (receptive field) of the input binary vector (Fig. 2). The states of the column are determined to be active (1) or inactive (0) based on the value of the connected binary vector and the strength of the connection (synapse). The internal state of the SP layer is represented by 0 or 1, that is, a binary vector in which almost all elements are zero, called sparse distributed representation (SDR). The internal state of the SDR then becomes the input for the Temporal Memory (TM) layer.

TM is made up of units called cells contained in the SP column, and is connected to cells in other columns. The state of TM cell is calculated similar to SP column from the value of the connection destination and the strength of the synapse. The internal state of the TM represents the SP column that becomes active at the next time, and the temporal anomaly score is calculated by the following formula (1). The actual predicted value can be obtained by creating a mapping (decoder) between the input value and SDR, but we do not use it because we only want to know anomaly score of the input.

$$\text{anomalyScore} = \frac{|A_t - (P_{t-1} \cap A_t)|}{|A_t|} \tag{1}$$

P_{t-1} : *predicted columns at time t*

A_t : *active columns at time t*

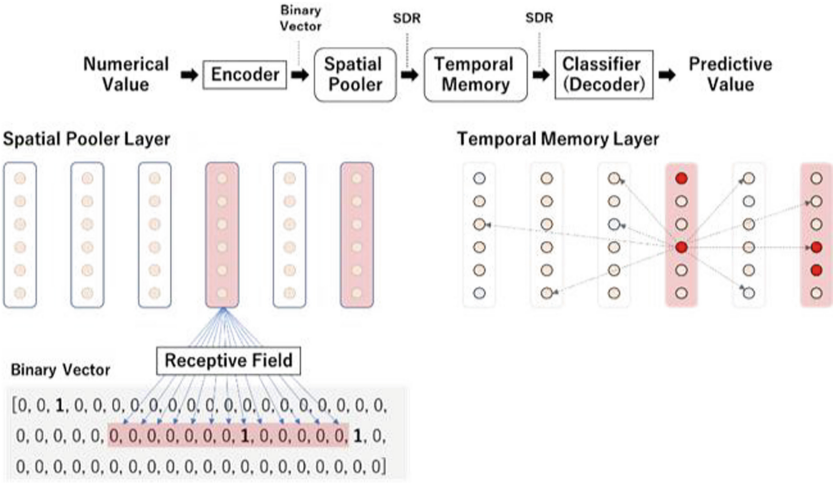

Fig. 2. Structure of Hierarchical Temporal Memory.

2.2 WordPiece and BERT Embedding

WordPiece is an algorithm developed as a tokenizer for neural language models. It can handle unknown words contained in sentences as meaningful tokens by breaking them into units called subwords. This characteristic of WordPiece is very favorable for us because log data so frequently includes keywords that combine multiple words like camel case. When entering tokens into the HTM, use the WordPiece dictionary to convert the tokens into indexes (integer values).

BERT is a general-purpose language model developed by Google, and distributed representations obtained from its intermediate layer and output layer can be applied to various tasks. Since the distributed representation obtained from BERT is expected to express the meaning of the token in consideration of the context, there is a possibility that a more efficient anomaly score can be calculated.

3 Experiment

In order to verify the learning status and anomaly detection accuracy of HTM in the three input formats, we will conduct a real-time anomaly score calculation experiment using the log file actually output from the Android device.

3.1 Method

In the experiment, we use 20 Android log data, which contain a series of output logs from device startup to termination. Information such as timestamps and process IDs are removed because they can have a negative impact when using distributed representations. In the log data, the following lines are artificially added to the 4000 to 4006 lines, and it is confirmed whether these lines can be detected as abnormal lines in the experiment. Before learning data and calculating the anomaly score, a new model is created for each log file, and the first line to the last line are entered only once in order (streaming format).

Anomaly lines artificially added to the log.

```
However, if you need to debug the python bindings using an IDE debugger it becomes a little more difficult.
The problem is that it requires a debug version of the python library, python37_d.lib. It is possible to
obtain one and link with it, but a way to better isolate the python extension is to build a special main()
as explained here: https://pythonextensionpatterns.readthedocs.io/en/latest/debugging/debug_in_ide.html.
Be aware that the CMake maintains a cache of build-time arguments and it will ignore some arguments passed
to CMake if is already in the cache. So, between runs you need to clear the cache or even better,
entirely remove the build/folder.
```

Table 1 shows the model parameters for the three input formats. In case of using word ID, the integer index is converted to a binary vector of length 60. When using the distributed representation, the size of the distributed representation of the BERT minimum model is 768, so use the singular value decomposition of the matrix to compress the size to 50. When using sentence embedding, take the sum of embedding after SVD for all tokens in the sentence. Each embedding element obtained in this way is converted to a binary vector of length 50, and the combined vector size is (50, 50). We used the Random Distributed Scalar Encoder from the htm.core[1] library to convert integer and floating point values to binary vectors. The anomaly score at each step is calculated by the method shown in Eq. (1) in Sect. 2.1 in any input format.

Table 1. Model parameters in three types input formats.

Parameters	Input format		
	Word ID	Word embedding	Sentence embedding
inputDimensions	(60)	(50, 50)	(40, 40)
columnDimensions	(1638)	(40, 40)	(30, 30)
potentialRadius	60	18	11
cellsPerColumn	13	16	16
activationThreshold	17	16	16

3.2 Scoring and Performance Measurement

Since the anomaly score calculated in the previous section takes a value from 0.0 to 1.0, we record the True Positive (TP), False Positive (FP), True Negative (TN) and False Negative (FN) values when the threshold is changed within that range. From these four values, three kinds of evaluation scores (precision, recall, f1) are calculated, and the threshold at which the f1 score reaches the maximum value is obtained. The threshold is optimized so that the score is the best when the entire 20 log data are considered as one data. The first 15% of the log data is treated as the model learning period and is excluded from the accuracy evaluation.

In parallel with the accuracy evaluation, the CPU time when the model learns and predicts one line of the log is measured, and the run-time performance in each input format is evaluated.

4 Results and Discussion

Table 2 shows the evaluation score of the anomaly detection experiment conducted in three types of input formats. The first row of the table shows the values of TP, FP, TN, and FN when the f1 score is maximized.

[1] https://github.com/htm-community/htm.core.

The input format where the F1 score was the highest was the word ID, and the runtime performance was the best among the three methods (Table 3). However, from a practical standpoint, it is inappropriate to present too many abnormal candidates, so further improvement in precision is necessary.

Table 2. Evaluations scores in each models.

Score	Input format		
	Word ID	Word embedding	Sentence embedding
TP, FP, TN, FN	102, 15981, 74016, 38	63, 12943, 77054, 77	110, 44675, 45322, 30
precision	0.0006	0.0048	0.0024
recall	0.7286	0.4500	0.7857
f1	0.0126	0.0096	0.0048
threshold	0.7480	0.9686	0.8788

Table 3. Average CPU time in each models.

Input format		
Word ID	Word embedding	Sentence embedding
0.0038 [s]	0.0179 [s]	0.0857 [s]

5 Conclusion

In this paper, we proposed a method to detect abnormal lines from log data using unsupervised learning algorithm HTM, and conducted anomaly detection experiment using output logs of actual Android devices. As a result, we found that the anomaly can be detected with the recall value of 0.79 at the maximum based on the anomaly score for each row calculated in the streaming format. However, detection precision needs to be further improved to suppress information that is useless to the user.

As a future task, we plan to develop a method to automatically search for the optimal model parameters for large-scale data.

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Intent Inference of Driver Deceleration Behavior by Using Unscented Kalman Filter Integrated with Conventional Artificial Neural Network Model

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Abstract. Early brake pedal operation and corresponding vehicle deceleration are crucial to mitigating rear-end collision risks. In this paper, a mathematical model, hereafter referred to as the deceleration intention inference system (DIIS), was developed to facilitate determining the intent inferences of driver deceleration behaviors. More specifically, a conventional neural network model was integrated into an unscented Kalman filter in an effort to describe the deceleration intentions that can be expected to occur a few seconds later. The numerical examples provided herein show that our proposed model is capable of inferring driver intentions more precisely than the conventional approach.

Keywords: Intent inference · Deceleration behavior · Unscented Kalman filter · Artificial neural network model

1 Introduction

Normally, a vehicle's brake lights are only activated to inform following vehicles of the driver's deceleration intention when the brake pedal is depressed. As long as this sequence remains the standard in current driving systems, following vehicles will be expected to reduce speed in response to the preceding car's impending deceleration. Additionally, even if autonomous (self-driving) vehicles, which have seen increasingly rapid development in recent years, become more accessible to the public, there is currently no other way to predict or infer the deceleration intentions of preceding vehicles in regular traffic situations.

Under such circumstances, slower reaction times, especially in high-speed or high-density traffic situations, result in significantly increased risks of front-end-to-rear-end collisions. However, if it were possible to develop a system that infers brake pedal action intentions and reports this information to the following car's driver in advance,

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the following vehicle would be better able to react before the brake lights of the preceding car illuminate, which could reduce rear-end collision risks.

To date, numerous studies have examined systems designed to infer driver intentions as active methods to improve traffic safety. Currently, most popular research is focused on determining ways to infer lane changing intentions. For example, McCall et al. [1] utilized head motion and vehicle car area network (CAN) data to estimate lane changing probabilities using sparse Bayesian learning (SBL), while Doshi and Trivedi [2–4] applied a support vector machine (SVM) and used head motion, eye gaze, and CAN data to make their predictions.

In a separate study, Salvucci [5] focused on steering angle and throttle pedal operation amounts in order to compute lane changing probabilities, while a study by Gunnarsson et al. [6] is the only known research that applies state-space modeling and a particle filter (PF) to the problem of simultaneously inferring lane changing behaviors and vehicle states. The intention inference was later extended to the problem of judging stop or go decisions at signalized intersections [7–9]. However, with the exception of our previous studies [10, 11], significantly less attention has been paid to the estimation and prediction of driver longitudinal behaviors.

The authors' studies mentioned above centered on the development of a deceleration intention inference system (DIIS) that is based on a state estimation created by an unscented Kalman filter (UKF) and combined with a conventional car-following model. In those studies, we confirmed that the DIIS performed well both in ordinary and sudden deceleration scenarios [10, 11]. However, two difficulties degrade DIIS precision. First, since both the state estimation and the intent inference models are isolated and independent, there is insufficient interaction between them. Second, the measurement equations that are essential components in the UKF are highly nonlinear but are defined by analytical and mathematical equations.

In order to overcome these difficulties, we have introduced conventional artificial neural network (ANN) models for use as the UKF measurement equations. In this paper, we investigate the performance of our updated DIIS in which the ANN models are integrated into the UKF.

2 Model Development

2.1 Fundamental Concept of Deceleration Intent Inference

The fundamental concept of deceleration intent inference is based on the Gazis-Herman-Rothery (GHR) model [12], which is well known as a conventional car-following model, and is defined by Eq. (1):

$$a_i(k+T) = \alpha \frac{v_i(k)^n}{d_i(k)^m}(v_{i-1}(k) - v_i(k)). \tag{1}$$

Here, v_i, d_i, and a_i are the velocity, headway, and acceleration of the i-th vehicle. k and T are the discrete timestep and vehicle reaction time, while α, m, and n are the parameters.

The GHR model has been used in numerous traffic simulations to calculate the vehicle acceleration that is expected to occur T steps later. However, as long as there is a delay before the following vehicle reacts, reaction time T cannot be neglected. In other words, if the current v and d are identified, we can predict the future acceleration a by using the GHR model. Accordingly, we began the model development based on the fact that delays are present between v, d, and a.

2.2 DIIS Outline

Next, we considered multiple vehicles forming a convoy, as shown in Fig. 1. Assuming that the second vehicle is equipped with sensors and a vehicle-to-vehicle (V2V) communication system to measure v_2, d_2, a_2, and v_1, our proposed DIIS estimates v_2, d_2, and v_1 together with I_2, which is considered to be the intended deceleration that is expected to occur 1.5 s later. Since the proposed DIIS is formulated by the UKF components, we define the state and measurement variables as $\mathbf{x}(k) = [v_2, d_2, v_1, \text{and } I_2]^T$ and $\mathbf{y}(k) = [v_2, d_2, a_2, \text{and } v_1]^T$, respectively.

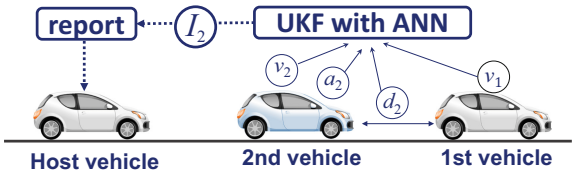

Fig. 1. In this three-vehicle convoy, the deceleration intention of the second vehicle is inferred and reported to the third vehicle's driver 1.5 s earlier than the braking action.

2.2.1 UKF State and Measurement Equations

By using conservation equations and the GHR model given in Eq. (1), the UKF state equations are given by:

$$v_2(k) = v_2(k-1) + a_2(k-1)\Delta t, \tag{2}$$

$$d_2(k) = d_2(k-1) + (v_1(k-1) - v_2(k-1))\Delta t, \tag{3}$$

$$v_1(k) = v_1(k-1), \tag{4}$$

$$I_2(k) = wI_2(k-1) + (1-w)a_2(k+T), \tag{5}$$

where Δt is the duration of the discrete timestep and w is a balancing factor ($0 < w < 1$). Substituting Eq. (1) into (5) yields:

$$I_2(k) = wI_2(k) + (1-w) \cdot \alpha \frac{v_2(k)^n}{d_2(k)^m}(v_1(k) - v_2(k)). \tag{6}$$

In addition, we obtain Eq. (7) by substituting Eqs. (2) to (4) into (6):

$$I_2(k) = wI_2(k-1) + (1-w)\cdot\alpha\frac{(v_2(k-1)+a_2(k-1)\Delta t)^n}{(d_2(k-1)+(v_1(k-1)-v_2(k-1))\Delta t)^m}(v_1(k-1)-v_2(k-1)-a_2(k-1)\Delta t). \quad (7)$$

Equations (2)–(4) and (7) consist of the UKF state equations, whereas the measurement equations can be defined as:

$$a_2(k) = g(\mathbf{x}_k), \quad (8)$$

$$d_2(k) = d_2(k),\ v_2(k) = v_2(k),\ v_1(k) = v_1(k) \quad (9)$$

Here, g is a conventional three-layered ANN model where the connection weights are all trained via a conventional back-propagation method. The introduction of I_2 and Eqs. (6) and (7) via the ANN model are key solutions to improving the DIIS precision.

2.2.2 ANN Model

The ANN model g in Eq. (6) is composed by three layers in which each neuron is connected across the layers, as shown in Fig. 2. The number of neurons in the input, hidden, and output layers are four, eight, and one, respectively. Let x_i, W_{ji}, W_{jk}, θ_j, and θ_k denote the state variables. The connection weights between the input-hidden layers, the hidden-output layers, and the offsets in the hidden and output layers results in an ANN model that computes a_2 as defined below:

$$a_2 = \varphi\left(\sum_j w_{kj}\cdot\varphi\left(\sum_i w_{ji}x_i + \theta_j\right) + \theta_k\right). \quad (10)$$

Here, ϕ is a sigmoid function. W_{ji}, W_{jk}, θ_j, and θ_k are all optimized through the training process by the use of a back-propagation method.

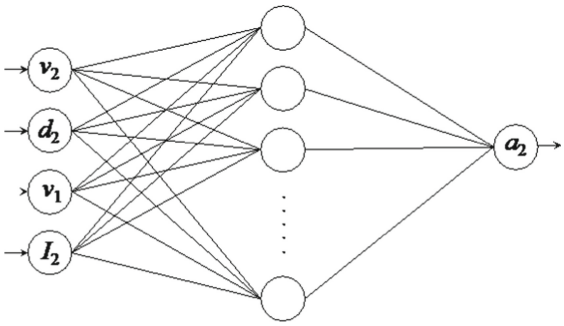

Fig. 2. A conventional ANN model is composed by three layers in which each neuron is connected across the layers. The inputs are four state variables, whereas the output is a_2.

2.2.3 State-Space Model

In order to apply the UKF to the state estimation and intent inference process, the following state and measurement equations are described as the state-space model:

$$\begin{cases} \mathbf{x}(k) = \mathbf{F}[\mathbf{x}(k-1), \mathbf{u}(k-1)] + \mathbf{v}(k-1) \\ \mathbf{y}(k) = \mathbf{G}[\mathbf{x}(k), \mathbf{u}(k)] + \mathbf{n}(k) \end{cases}, \tag{11}$$

where **F** and **G** are the appropriate functions for the state and measurement equations and **v** and **n** are system and measurement noises. **u** is an input to the system.

2.3 UKF

The UKF is a *derivative-free* Kalman filter that does not require partial derivative calculations of the state and measurement equations [13]. In the conventional extended Kalman filter (EKF), all the state and measurement equations should be defined in analytical forms in order to obtain the partial derivatives. The use of the UKF enables us to define Eq. (6) using non-analytical formulas such as ANN models in which the partial derivative is not required to compute the Kalman gain. Note that, due to the page size limitation of this article, readers should refer to [10, 11] for additional details about the UFK calculation procedure.

3 Numerical Example

In this study, the evaluation data used were collected from a driving simulator experiment carried out in our previous study [11]. Figure 3 shows a comparison between the inferred deceleration intent prediction of the conventional method and our proposed DIIS. When focusing on a high deceleration scenario at around 60 s, it can be seen that the DIIS prediction is closer to the real deceleration action than the prediction that can be obtained using the conventional approach. It was also found that, because of the introduction of the state variable I_2 and the integration of the ANN model into the UKF, the proposed DIIS achieved a more precise deceleration intention prediction.

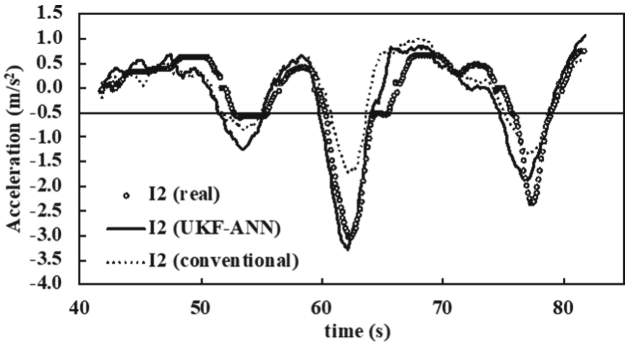

Fig. 3. When focusing on the high deceleration observed at around 60 s, predictions obtained via our proposed DIIS showed better goodness-of-fit with the actual deceleration than could be obtained using the conventional approach.

4 Conclusion

In this research, we integrated a conventional ANN model into a UKF in order to achieve more precise inference of driver deceleration intentions. First, the state and measurement equations of the UKF were firmly modeled by using the ANN model. Then, via numerical analyses, we confirmed that the proposed DIIS performed better than the conventional approach in terms of inferring intended deceleration actions.

In our future research, we expect to test our proposed DIIS using additional data and participants in various car-following situations.

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A Deep Learning Approach for Fishing Vessel Classification from VMS Trajectories Using Recurrent Neural Networks

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Abstract. Satellite-based vessel monitoring systems (VMS) have been widely deployed on fishing vessels for monitoring and surveillance. In this study, we aim to enhance the classification of fishing ship trajectory from the VMS data. We propose a recurrent neural network (RNN)-based approach for discrimination of fishing vessel types from ship trajectories. Our proposed method first eliminates data points that are meaningless by identifying groups of data points describing ship movements using a density-based clustering strategy. We then generate local trajectories and compute a feature vector for each identified group as input for RNN. Finally, we train RNN models to learn high-level representation of ship trajectory for the task of classification. Experiments conducted on real-world VMS records among three fishing ship types: trawl, purse seine, and falling net demonstrate the effective use of RNNs and bidirectional GRU performs the best performance with 89.74% accuracy.

Keywords: VMS · Ship trajectory classification · RNN · Deep learning

1 Introduction

Satellite-based vessel monitoring system (VMS) is a powerful tool for fisheries monitoring control and surveillance [1]. VMS provides spatio-temporal information about a fishing vessel, including GPS positions, instant speed, and course over ground and rate of turn in time intervals. Over the years, researchers have made use of VMS tracking data for fishing studies. For example, calculation of fishing diversity [1] and efforts [2]. Many studies focused on detection of fishing activities during a trip using different algorithms such as setting appropriate thresholds of speed [3] and machine learning [4, 5]. However, these previous works often depend on the knowledge of fishing vessel type as the preliminary. Furthermore, they are not applicable for serveral types of vessel. Therefore, the question is how to identify fishing boat types from VMS records. Despite this, a few efforts has been made to distinguish the fishing vessels among different types from VMS tracking data. For example, the study [7] simply used operational speeds while fishing as a key indicator for characterizing trawls and longlines. More sophisticated methods that use machine learning have been proposed to identify some types of vessels. In [8] Mixture of Gaussian is applied to generate

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features of each vessel type and then use Support Vector Machines to learn a model to discriminate different vessel types. A method that learns speed profiles of nine types of fishing vessels was studied in [9]. Nevertheless, analysis of VMS tracking data for fishing vessel classification still poses a challenge because the number of sampled points are huge and many of them are meaningless, easily hiding the effectiveness of classification models.

Motivated by the great success of recurrent neural network (RNN) on a wide range of applications, we aim to enhance the classification of fishing ship trajectory using RNN. The highlight of RNN and its variance (e.g., LSTM [10], GRU [11] and bidirectional RNN) is the ability to learn temporal patterns from sequences of data to yield discriminative power. In this work, we propose a RNN-based approach for distinguishing fishing vessel types from VMS ship trajectories. The idea here is that different fishing boat types have different movement patterns and RNNs have a potential for identifying them. Our proposed approach first separate segments of ship movements from VMS trajectory using a density-based clustering scheme. Particularly, DBSCAN [12], a point-based spatial clustering algorithm, is adopted to identify groups of sampled points that are meaningful for describing specific patterns of ship movement. It also enables to eliminate data points that are meaningless. After that, we generate local trajectories and then compute VMS-related features, including speed, distance, direction and tuning angle. Finally, RNN models are trained to learn high-level representation of ship trajectories for classification of fishing vessel types.

2 VMS Records

Originally, each VMS record consists of the position of a vessel, status of ship movement, timestamp, instant speed, distance from last move and heading angle. VMS typically generates data points at predetermined intervals from half hourly to two hours. In this study, we target on three types of fishing vessels: trawl, purse seine and falling net and briefly give the definitions as follows.

- **Trawl:** trawling involves fishing with dragged net behind a vessel. While fishing, the vessel typically slows down and maintains a constant speed to drag the net in the water. Duration of trawling can last from few hours to several hours.
- **Purse Seine:** fishing with surrounding net captures fish by quickly encircling them. While operating, the vessel usually moves around the prey using high speeds to avoid fish escaping. The duration of fishing can vary from one to several hours.
- **Falling net:** fishing with falling gear catch fish by clapping down the prey. The vessel while fishing travels at very low speeds or almost stopping and move to different locations. The whole operation can take up to hours or daylong.

We also perform the following steps for preprocessing the VMS data. We first separate each individual trip from the whole overlapping traces as vessels depart and enter ports by locating the ports using map information. Second, we remove all harbor positions (apart from the last position before leaving the harbor). Each consecutive position outside harbors constitutes a trip bounded by a departure and an arrival harbor.

3 Recurrent Neural Networks

A recurrent neural network (RNN) [11] has a powerful method for modeling sequential data. RNNs use recurrent connections to retain the state information between different time steps that take the form: $h_t = \sigma(W_{xh}x_t + W_{hh}h_{t-1} + b_h)$ and $y_t = \sigma\left(W_{hy}h_{t-1} + b_y\right)$ where y_t and h_t denote the output and the hidden node at the time t. The W terms denote weight metrics and the b terms denotes bias vector and σ is an activation function. Long short-term memory (LSTM) [10] architecture has been introduced to address the gradient vanishing problem of RNN. LSTM that uses purpose-built memory cells to selectively store information is better for modelling long-range context. The following composition function:

$$i_t = \sigma(W_x x_t + W_h h_{t-1} + W_{ci} c_{t-1} + b_i) \tag{1}$$

$$f_t = \sigma(W_x x_t + W_h h_{t-1} + W_{ci} c_{t-1} + b_i) \tag{2}$$

$$c_t = f_t c_{t-1} + i_t \sigma(W_x x_t + W_h h_{t-1} + b_c) \tag{3}$$

$$o_t = \sigma(W_x x_t + W_h h_{t-1} + W_{ci} c_{t-1} + b_o) \tag{4}$$

$$h_t = o_t \sigma(c_t) \tag{5}$$

where i, f, o and c are the input gate, forget gate, output gate and cell activation vectors respectively. Alternatively, the Gated Recurrent Unit (GRU) [11] architecture is introduced with fewer parameters, leading to easier training and require less training samples. GRU is formally defined by:

$$r_t = \sigma(W_{xr} x_t + W_{hr} h_{t-1} + b) \tag{6}$$

$$z_t = \sigma(W_{xz} x_t + W_{hz} h_{t-1} + b) \tag{7}$$

$$\tilde{h}_t = \sigma(W_x x_t + W_h(r_t \odot h_{t-1})) \tag{8}$$

$$h_t = (1 - z_t) \odot h_{t-1} + z_t \odot \tilde{h}_t \tag{9}$$

where r, z denote the reset and update gate. $\tilde{h}_t, h_t$ denote the candidate cell state and the final cell state at t respectively. $\odot$ denotes element wise multiplication.

4 The Proposed Method

4.1 Trajectory Segmentation

We first need to identify segments of specific ship movements. We apply DBSCAN algorithm [12] to discover interest groups of the sampled points. DBSCAN is a density-based spatial clustering algorithm that allows defining density of the region around a data point as the number of points in a neighborhood, N_ε with a constant radius ε. To be

noise tolerant, the region is identified as dense if this number is greater than a threshold τ. The main advantage of DBSCAN is that it does not require a predefined number of clusters. However, the accuracy of DBSCAN often depends on the selection of the parameters ε and τ. In this work, we propose a heuristic strategy for automatically determining ε and τ. The idea is to estimate the distance from each data point to its nearest neighbor and then count each point's neighbors within a specific distance. For ε, we generate distribution of distance from each point to it nearest neighbor. The reasonable ε can be specified by preserving the vast majority of points that lies within the sorted distances. The minimum points τ can be chosen by distribution of counts for each point's neighbors with the selected value ε. A reasonable value for τ is the value at which a sharp increase in the distribution (Fig. 1).

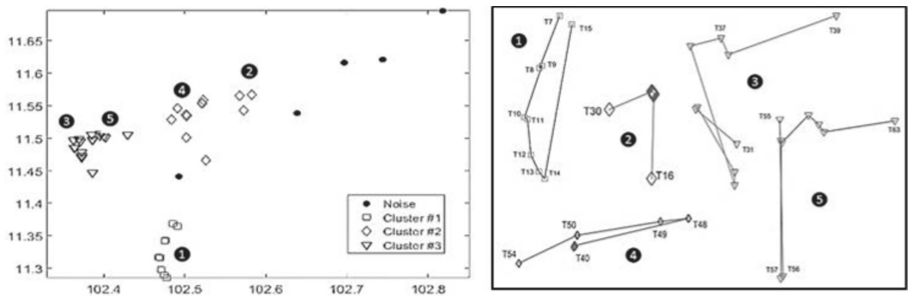

Fig. 1. Trajectory segmentation (*left*) the result of DBSCAN with heuristics and (*right*) generation of local trajectories

4.2 Feature Extraction

Once local trajectories were identified, we perform to extract a feature vector for each local trajectory. For each trajectory, global descriptive statistics of its movement parameters (speed and distance) are computed, including the minimum, maximum, mean and variance over the entire trajectory. Such descriptors are essential for modeling and characterizing the movement patterns of fishing vessel. In addition, because of the fact that movement patterns may change over time, we perform to extract local invariant features of the fishing trajectory. In this work, all turns and changes of directions of a fishing track are extracted. Given a set of n time-stamped 2D coordinates $\{(x_1, y_1), (x_2, y_2), \ldots, (x_n, y_n)\}$ of the trajectory, we first calculate directions between all the consecutive coordinates. A direction $\mathcal{D}ir$ between two consecutive points $P_i = (x_i, y_i)$ and $P_j = (x_j, y_j)$ defined by:

$$\mathcal{D}ir = \begin{cases} 90 - \Delta, & x_j \geq x_i, y_j > y_i \\ 90 + \Delta, & x_j > x_i, y_j \leq y_i \\ 270 - \Delta, & x_j \leq x_i, y_j < y_i \\ 270 + \Delta, & x_j < x_i, y_j \geq y_i \end{cases} \tag{10}$$

where $\Delta = \sin^{-1}\left(|y_j - y_i| / \sqrt{(x_j - x_i)^2 + (y_j - y_i)^2}\right)$. The range of direction is between 0 and 360°. A turning angle θ is defined as the change in direction of movement and is given as the following formula.

$$\theta = \begin{cases} |\mathcal{D}ir_{new} - \mathcal{D}ir_{old}|, |\mathcal{D}ir_{new} - \mathcal{D}ir_{old}| < \pi \\ 2\pi - |\mathcal{D}ir_{new} - \mathcal{D}ir_{old}|, otherwise \end{cases} \tag{11}$$

where $\mathcal{D}ir_{new}$ and $\mathcal{D}ir_{old}$ denote directions of two consecutive movements and $\pi = 180^{\circ}$. The range of turns is between 0 and 180°. Once all turns and directions of the points are computed, the angles and changes of the directions are encoded into histograms: direction histogram and angle histogram. The former stores all the directions between two consecutive points. It comprises a total of 12 bins with directions quantized at 30° interval, i.e. [0 − 30, 31 − 60, …, 330 − 360]. The latter captures angular distribution of the movement patterns in the trajectory. It comes up with 12 bins of turning angles between two directions quantized at $\frac{\pi}{12}$ radian interval. There are a total number of 32 features describing characteristics of ship movements.

4.3 Network Architecture

Once trajectory features were extracted, we feed them in RNN network. Given $T_i = \{S_1, S_2, \ldots, S_m\}$ be a sequence of trajectory segments extracted from the entire trip where S_j denotes a feature vector of the j^{th} trajectory. This network contains two LSTM/GRU layers stacked on the top of each other. One GRU layer goes in the forward direction and another one goes the backward direction. The output of each time step t is not only dependent on the previous trajectories, but also on the upcoming ones. The final hidden state of each LSTM/GRU layer is also concatenated to produce a feature vector of ship trajectory. We use sliding window to divide each sequence of trajectories into fixed-length k windows with overlapping. We set the window length $k = 15$ because it is the best value for our experiments. Finally, we add one hidden layer and then use softmax classifier to predict the output label.

5 Experiments and Results

Our proposed approach is evaluated on real-world VMS data recorded by Thailand Command Center for Combating Illegal Fishing (CCCIF). This dataset consists of three common types of fishing vessels with 632,650 records of 199 fishing trips (89 of trawl trips, 61 of purse seine trips and 49 of falling net trips) in total for training and testing phrase. We perform a 5-fold cross validation procedure and use standard measures of accuracy (precision/recall) for performance evaluation. Comparison with simple RNN models, both GRU bidirectional RNN (GRU-BRNN) and LSTM bidirectional RNN (LSTM-BRNN) outperform RNN models on the F1 score. This demonstrates that bidirectional RNNs that can take advantage of the expressive power introduced by

using forward and backward layers captures more complex relationships compared to RNN models that use a single layer.

Table 1. Performance comparision of different models

Proposed model	Precision	Recall	F_1
GRU-RNN	0.876	0.795	0.834
LSTM-RNN	0.805	0.851	0.827
GRU-BRNN	**0.884**	**0.877**	**0.880**
LSTM-BRNN	0.826	0.849	0.837

Table 2. Classification rate on different fishing vessel types

Ground truth	Predicted labels (%)		
	Trawl	Purse seine	Falling net
Trawl	**89.78**	0.00	10.22
Purse seine	1.54	**98.46**	0.00
Falling net	25.00	0.00	**75.00**

Table 1 shows that GRU-based networks (GRU-RNN and GRU-BRNN) tend to get slightly better result than LSTM RNNs (LSTM-RNN and LSTM-BRNN) over the measures, GRU-BRNN achieve at least 6% and 8% absolute improvement in F1 score. This result highlights the efficient use of GRU for the task of trajectory classification. Compared to the SVM model that uses a single feature vector to assign a category of fishing method, the significant improvements of all RNN-based models are obtained by modelling sequence data. Table 2 demonstrates recognition rate on the three categories. Among these categories, Purse seine category achieves the highest recognition rate, at least 98% recognition rate on the test data is achieved by GRU-BRNN.

6 Conclusion

In this work, we present a deep learning approach for characterizing fishing vessel types form VMS tracking data. We handle the issue of VMS ship trajectories by identifying segments of data points describing ship movements of fishing vessel type using a density-based clustering scheme. We also extract VMS-related features for capturing characteristics of specific movements. Finally, a bidirectional RNN model with LSTM/GRU is designed for the task of classification. Experimental results conducted on real-world VMS tracks demonstrated that our proposed approach achieves encouraging performance of recognition rate, compared with other RNN-based models.

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An AcciMap for the Kleen Energy Power Plant Project Explosion

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Abstract. Project accidents, especially accidents and disasters in the industrial sector continue to occur, in most cases with tragic consequences involving the loss of lives [1]. Long-term research shows that there is a vital need for application of systemic cause-consequence analysis techniques that embrace all aspects of the system [2–5]. Such analyses aim to provide safety by finding ways to prevent potential accidents in large-scale projects [6, 7]. This paper analyses the cause of a large explosion that occurred during the construction stage, at the Kleen Energy power plant project in United States, on 7th of February 2010 [1, 8–10]. To this end, a causal analysis of the project explosion has been conducted based on Rasmussen's [11, 12] AcciMap technique. The AcciMap is a systemic accident analysis technique, which is focused on the performance of the system as a whole [4, 12, 13].

Keywords: Construction management · Construction industry safety · Accident investigation · AcciMap · Project delivery failure

1 Introduction

There were occurred a large explosion at the Kleen Energy power plant project (project) in Middletown in United States on 7th of February 2010 [8–10]. This explosion destroyed part of the building (Fig. 1), killed 6 people and injured 50 more [1, 8–10, 14].

The current paper analyses the causes of this explosion using the systemic cause-consequence analysis based AcciMap technique [4, 11, 12]. It is based on the idea that multiple factors, rather than a single one lead to the project failure [11–13].

The data for this study was gathered from the different online sources including interviews, articles, official press and media reports [1].

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Fig. 1. The Kleen Energy power plant project in Middletown, United States is seen on 7th of February 2010, after explosion [14].

2 Results

2.1 Causal Analysis of the Kleen Energy Power Plant Project Explosion

The AcciMap output comprises six hierarchical levels, as shown in Fig. 2. The lowest level presents the *outcomes* of the project failure, i.e. the explosion. In this case, the explosion resulted in the death of six workers and injuries to 50 more, and destroyed part of the building [1, 8–10, 14], as the explosion occurred under the final stage of the construction, close to the start-up commissioning stage of the project [8, 9, 15].

Going upwards, the next level is *'immediate causes'* which begins to answer the question 'Why did this explosion occur?' The primary causes of the explosion are presented in the pink boxes and include: 'inappropriate location for implementing the purging operation', 'finding ignition source' and 'natural gas piping explosion'. In this part of the project, a planned gas purging operation was being carried out, in which a high velocity flow of natural gas was used to remove the debris [10, 16] and welding contaminations from the new pipes [16, 17]. The workers, who included technicians and gas operators, were using the natural gas at a high pressure of approximately 650 psi [16, 18]. During this planned work activity, the natural gas encountered an ignition source and exploded [16–18].

Natural gas is the most dangerous and risky type of combustible material to use in carrying out the gas purging process [16, 17]. According to the US Chemical Safety Board [16], gas purging is a quick and easy process, provided all safety requirements are met; otherwise it can lead to calamitous incidents.

In addition to aforementioned primary causes of the project explosion, there were several other secondary or so-called 'latent' causes, including 'reliance on technicians/gas operators', 'failure to wear protective gear' and absence of safety meetings on the day of the explosion [16, 17, 19, 20], which are presented in blue boxes at the *'immediate causes'* level of the causal chain of events. Based on the review of the available sources, it was clear that violations of safety procedures took place, and overreliance on technicians and gas operators who were only partly trained on how to carry out the gas purging operation [16, 20]. All these failures made a significant contribution in causing the explosion.

The third level is the *'organisational cause'* level, which incorporates the causes stemming from organisational processes of the entire Kleen Energy power plant project, as the project was functioning as a whole organisation. The primary causes placed at this level are 'insufficient commitment of hierarchy of controls' and 'inappropriate supervision by company managers' [16, 20] (Fig. 2).

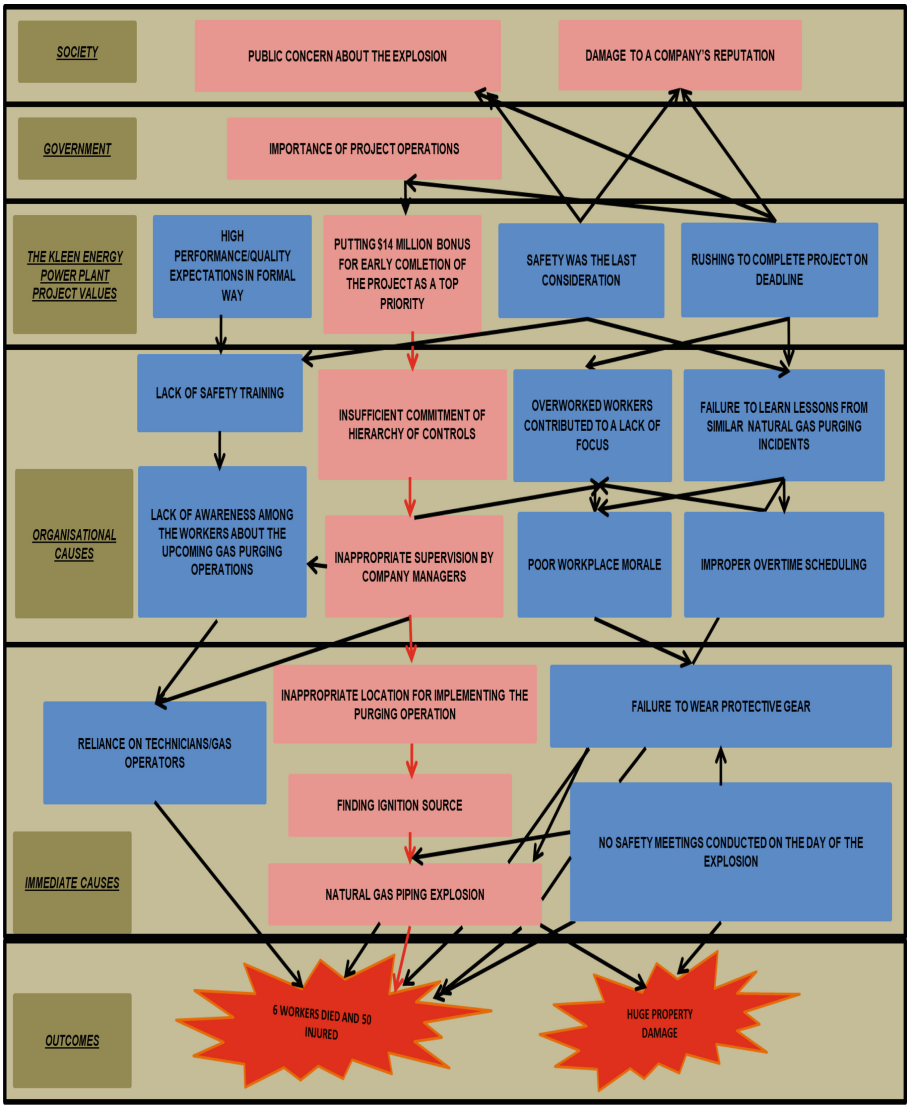

Fig. 2. AcciMap for the Kleen Energy power plant project explosion.

In October 2010, the US Chemical Safety Board [16] investigated that "…the pipe cleaning crew did not have a safety meeting that specifically discussed the hazards of natural gas blows, nor did they receive and review the natural gas blow procedure". Approximately 150 workers were at the construction site on the day of the explosion; while some of the workers were informed that natural gas blows would be occurring, others did not learn about the planned natural gas blows until they reported to work that morning [16, 20]. Certainly, these facts explicitly reveal the latent causes of the explosion as a lack of awareness among the technicians, operators and supervisors about the upcoming gas purging operations. Furthermore, according to the US Chemical Safety Board [16] there were at least nine similar natural gas purging explosions have occurred involving multiple injuries and death since 1999. However, it appears that no lessons had been learnt by the management of the Kleen Energy power plant project which in turn has caused similar mistakes.

According to additional investigation results [19–22], human exploitation factors also emerged. Erik Dobratz, a son of one of the workers killed in the blast claimed that his farther Ray had told him that he and other workers were putting in 12 to 13-h days, seven days a week at the construction site of the project [1, 20]. He claimed that the company was pushing the workers to finish the project. The boy suggested that the gruelling hours "…if something comes out that someone forgot to do something, could it be because they were really tired and thought they did do it and didn't do it…?" [20] might have contributed in some way to the explosion.

The Kleen Energy project involved a 620-Megawatt magnitude power plant [20–22] built by a giant construction companies such as Bechtel and Fluor, but as the lead contractor was selected O&G Industries [20, 21]. O&G company agreed to deliver a new style power plant with an effective electricity generation for $760 million on November 2010 [21]. According to the Fitch's rating report of the Kleen's bonds, the extra '$14 million bonus will be paid' [20, 21] (see Fig. 2. *'The Kleen Energy power plant project values' level*) if O&G Industries complete the project early than agreed time. To speed up the project completion, managers of the project neglected safety issues, especially in the 'improper overtime scheduling', 'poor workplace morale', 'not wearing the protective gear' and 'lack of safety training'.

Finally, the top levels 'government' and 'society' incorporate effects after the explosion such as 'public concern about the Kleen Energy power plant project explosion', 'damage to a company's reputation' and 'importance of project operations'.

To summarising the findings of the cause-consequence AcciMap, it shows that to meet the tight project schedule, the primary contractor O&G Industries violated workplace safety standards, regulations and rules, resulting in a variety of inadequacies and failures [16, 17, 19–21]. Moreover, the workers were under pressure to complete the work as quickly as possible. Additionally, there was a lack of hierarchical control by management, which affected the successful delivery of the project [16, 20]. The analysis concludes that the project failure of the chain of command to operate mainly lies at the values of the Kleen Energy power plant project. Thus, it appears that the values of the project should be reconsidered in which they affect and condition possible project explosion.

It should be borne in mind that the aim of applying a vertical cause-consequence AcciMap analysis in the current study is not to point to guilty individuals responsible for the explosion that occurred in this project. It rather highlights the decision-makers who could have made the right decisions that might have changed the Kleen Energy power plant project priorities and thus led to the prevention of the calamitous consequences.

3 Conclusion

Through the use of AcciMap, this paper has presented an overview of the Kleen Energy power plant project failings that resulted in a disastrous explosion. It started by the providing the key causes at the construction stage of the project at which the project explosion occurred. The use of the AcciMap has provided a map of how the whole process happened in the Kleen Energy project, particularly focusing on the problems and difficulties which resulted in the project explosion.

The analysis of the Kleen Energy project explosion using the AcciMap not only provides a platform for the investigation of the accident, but also embraces issues regarding safety provision and emphasises finding ways to prevent future accidents.

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Forecasting by Using the Optimal Time Series Method

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Abstract. The research objective is to discuss the adoption of the wavelet transformation method (WT) in processing time series, for its efficiency. As well as comparing modern methods represented by wavelet and neural networks with traditional methods represented by Box-Jenkins models, to better diagnose the treatment of any series, whether (linear, semi-linear or non-linear), a way to minimize the error to the nearest zero value, through the use of error accuracy measurements to diagnose the best method among classical and modern methods, some of them are characterized by artificial intelligence (IT) to measuring the accuracy of best forecasting methods in time series. Artificial neural networks (ANN) also used as one of the uses of artificial intelligence (IT) for best results. statistical error criteria have been adopted for comparing and evaluating the efficiency of the methods adopted: (MSE, RMSE, MAPE), Mat lab 8th edition was used. An important conclusion reached, was finding the best technique that minimizes the error to its lowest value with an average error close to zero significantly.

Keywords: Wavelet transformation · ANN · Box-Jenkins models · Accuracy error · Time series forecasting

1 Introduction

Recently, in many research studies on various forms of numerical analysis, time series prediction modern techniques were proposed. There are countless forms of modern forecasting methods applied to resolve various kinds of problems. A new development is proposed and summarized for the time series research relevant to the wavelet transformation method [12].

From the start, a great deal of research on wavelet for time series examination focuses on periodgram and scalogram analysis of periodicity & cycle assessments. In this situation, a good decomposition is provided from wavelet transformation from a signal or time series to allow parametric or non-parametric models to evaluate the structure [13]. There's been a growing interest in modern methods of time series forecasting, including wavelet transformations and ANN, so it was important to

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compare the usual methods used in time series estimation with contemporary methods to find the most efficient forecasting method [10, 11]. This paper proposes to diagnose the most accurate time series solution, using the following methods: artificial neural network, wavelet, and Box-Jenkins. It was set to Nuclear electric power data: which could be identified as electricity generated using thermal energy released from the fission of nuclear fuel in the reactor. Uranium was discovered in 1939, and provides as much energy as ordinary fossil fuels called fissile nuclear power. This discovery was not the result of a moment, but since 1896, when X-rays were discovered, the result of scientific advances began [13]. It was not long before nuclear power was put into practice until a new nuclear power source called "fusion energy" was seized and fuelled [9]. The structure of this research is distributed into two main parts as follows: the theoretical part, which contains the concept of Time series and Box-Jenkins models (BJ), Wavelet transformation.

2 Method

2.1 Time Series and Box-Jenkins Models (BJ)

A time series is well-defined as a system of observed values for a specific time-related random phenomenon [14]. In order to describe the reliability of the time series in question, certain numerical parameters are used to stimulate their displaying [15]. These parameters are the feature of autocorrelation ACF, the coefficient of autocorrelation between −1 and 1. The function of partial autocorrelation (PACF) tests the partial result of applying lagged values to a variable. And it is easy to acquire PACF constants from the Autoregressive calculation of series in [7]

$$\Phi p(Bs)\,\Phi p\,(B)(1-B)d\,(1-Bs)D\,Yt = \Theta Q\,(Bs)\,\theta q(B)\,et \tag{1}$$

2.2 Wavelet Transformation (WT)

Wavelet is a modern topic that has been used widely to address time series in recent years. The wavelet analysis is a complement to Spectral analysis, which is based on the conversion from time-domain to frequency-domain dependent on Fourier transform (named after Joseph Fourier, a French mathematician who defined Fourier transformation "the fragmentation of the series into the sum of several compounds" Sinusoidal [5]. A Wavelet Transformation (WT) is a mathematical method used to separate a particular function or continuous signal into different modules of the scale [1, 12, 14]. Typically a frequency spectrum can be allocated to every single component of the scale, Every single element of the scale can then be analyzed with a resolution equal to its measurement [3]. A WT is an illustration of a function's wavelets. Wavelet transformations have benefits over conventional "Fourier" transformations to accurately characterize functions with discontinuities and sharp peaks and to decode and reconstruct finite, non-periodic and/or non-stationary signals accurately [17]. constant wavelet transformation (CWT) and discrete wavelet transformation (DWT) [2, 12]. The discrete wavelet transform (DWT)/where T is the signal length f(t) [17, 20].

$$W_{(m,n)} = 2^{-\left(\frac{m}{2}\right)} \sum_{x=0}^{i-1} f_{(x)} \varnothing \left(\frac{x - n \cdot 2^m}{2^m}\right) \quad (2)$$

The factors of ascending and transformation are functions of the numeral variables m and n (a = 2 m, and b = n · 2 m), and t is the separate time index.

The analysis is based on rates describing the quantitative phases. The first step of the study analyzes two aspects of the unique sequence S, the approximate A1 and the other detailed part D1. The string is S = A2 + D2 + D1, etc.

The second level can be the estimated part A1 and the complete part D1 titled Packet analysis, so the series is S = AA2 + DA2 + AD2 + DD2, the series could be allocated to any "r" level where r is a positive integer [11, 15].

2.3 Artificial Neural Networks

ANN Is an information processing system built on a simple computational model that simulates the neural networks of the 'neural system' with certain performance features, and it is considered a non-linear model [2]. The artificial neural network was developed in 1958, represented by Perception [8].

The perception contains neurons, nodes or units that reflect the inputs that simulate the signs inflowing the biological nerve cell [4]. The signs among the nodes move through the "neurons" Each line is bound to a definite load, and these loads subtract the signals entering the node and then accumulate the balanced outputs in the nodes or neurons [5]. A non-linear function processes the outputs of each node with a threshold called the stimulation factor. Figure 1 demonstrates the ANN overall method [3, 16].

The neural network is made up of at minimum 3 levels and there are many nodes in each level. The first level is the input and the second level is the output, while the other level is the hidden layer. This layer exists between the level of input and the level of output. There are some nodes in each grade [5, 6, 19]. Figure 1 demonstrates the ANN engineering structure.

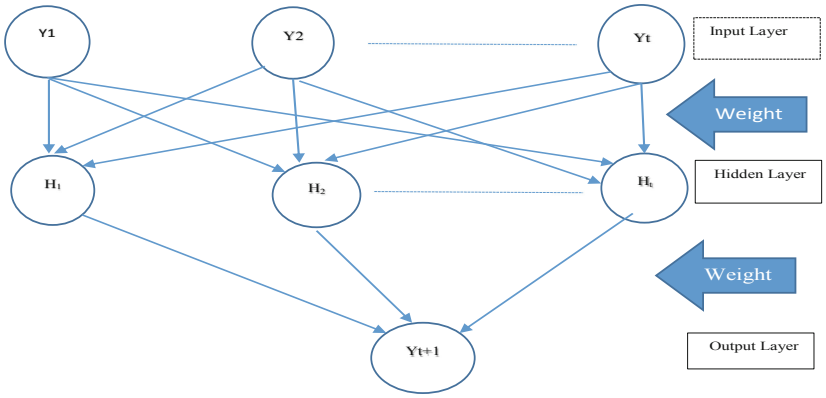

Fig. 1. Methodology of artificial neural networks

2.4 ANN and Time Series

In handling & evaluating time series and Box-Jenkins models, ANN is progressively Gaining significance for self-learning & exercise [15, 18]. Both assumptions are based on the Box-Jenkins model and, in particular, autocorrelation and partial autoregressive function (ACF, PACF). The input and output of the grid for the time series is specified by the following hypothesis: inputs network are determined or diagnosed by lags the series by the degree of the autoregressive model in the ARIMA model, moreover, the output network represents the time series of the period t and explained below [2, 3, 6]

$$y_{t+h} = f_h(yt, \ldots, yt - n + 1) \tag{3}$$

3 Application

In this section, the time series data for nuclear power was adopted at the level of Asia to calculate the accurateness of prediction methods. And Table 1 shows data on the production of nuclear power for Asia for the period 1980–2006, according to the US Energy Information Administration.

Table 1. Represents the production values of nuclear power in Asia

Year	Production	Year	Production	Year	Production	Year	Production
1980	92.73	1987	262.7	1994	364.02	2001	483.29
1981	98.99	1988	246.47	1995	393.74	2002	478.32
1982	113.24	1989	250.49	1996	417.22	2003	450.23
1983	135.55	1990	279.92	1997	438.19	2004	497.57
1984	165.87	1991	295.39	1998	462.35	2005	537.9
1985	198.26	1992	305.78	1999	463.3	2006	542.86
1986	216.44	1993	334.15	2000	478.65		

4 Results

To solve the series of nuclear power production for Asia for the period 1980–2006, contemporary prediction methods were adopted by wavelet transformations and artificial and traditional neural networks represented by Box-Jenkins models. The results were as follows:

4.1 ARIMA Models

Based on the autocorrelation and partial correlations function in Fig. 1, the best model for this series follows the ARIMA (1, 1, 0) model and the mathematical model is

$$(1 - \varnothing 1B)(1 - B)\ Yt = et \tag{4}$$

It is clear from the examination of the residuals through the values of the coefficients of the autocorrelation and partial autocorrelation function coefficients of the errors that all are not significant. The probabilistic value of the test is not significant at the level of significance of 5%. This leads us to accept the null hypothesis which states the independence of random variables The autocorrelation coefficients of the resulting spores in this model are zero and non-significant. Therefore, the errors are independent and random; indicating that the estimated model ARIMA (1, 1, 0) is appropriate and is the best.

4.2 ANN

The ANN inputs of the original series through shift time series, of degrees "Lag1, Lag2" or more. We will deliberately remove two degrees in order not to complicate the modeling process and the mathematical model. The multi-layer network (BP), one of the largest and most popular forms of ANN, is approved in the processing, forecasting, interpretation, and statistics classification of time series.

The nominated network contains of three layers (input, concealed, output) consistent with links or weights, as the trade-off between them is determined by the MSE error rate. The network input is determined by the two series "Lag1, Lag2", so the input grid will be Xt − 1, Xt − 2 and the output will be Xt. Where Xt is the time series being searched. shows the results of BP error parameters in Table 2.

4.3 Wavelet Transformation

In this study, the Wave analysis was used to filter and divide the time series into its main components, using the db3 function, estimating the details and rounding factors at levels 1, 2 and 3. Calculating the estimated signal series for a split for level 3. The results were extracted by Mat lab 8th edition. The results were as shown in Table 2.

4.4 Results Analysis

To compare the methods adopted and evaluating their efficiency, statistical error criteria have been adopted: (MSE, RMSE, MAPE). The results of Forecasting Accuracy for the methods adopted can be briefed in Table 2 shows the behavior of RMSE.

Table 2. Outcomes for forecasting accuracy

Method	Criteria		
	MSE	RMSE	MAPE
BJ	8.53	2.92	**5.613**
ANN	0.095	0.308	0.0369
WT	2.21E−26	1.49E−13	**3.65E−14**

The results of the statistical criteria for the methods adopted in Table 2 show that the wavelet and neural networks are better, but the wavelet transfers method are almost zero.

5 Conclusion

The conclusion reached by this research can be briefed on the following:

(1) the best technique that reduces the error to the lowest rate and the average error is close to zero significantly for the nuclear power production series in Asia is in the wavelet transformation method, Although the series is linear and its length is short, its efficiency is known in large size series.
(2) The results proved the accurateness of the wavelet transformation method in solving time series, whether linear, semi-linear or non-linear.
(3) The percentage of improvement in the error results for each, wavelet method vs NN and Box Jenkins models is 100%, either the neural network's method vs Box-Jenkins is 89%.
(4) The results proved the efficiency of modern methods to solved time series, these techniques can significantly reduce the extent of the error.

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Calculation and Visualization of the Speed of Movement of the Working Point of the Exploratory Research Process

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Abstract. Today it is important to reduce the time spent on exploratory research. To achieve the goal, problems are solved from the field of computer science and cybernetics, which are interdependent. The article proposes new theoretical approaches to the mathematical representation and visualization of moving the working point of the exploratory research process along the planes of the xyz coordinate system. For this, formulas were obtained for the speed of movement of the working point, which reflects the course of the exploratory research. They were obtained using differentiation of the formulas of the dependences of the probabilities on the flow intensity and the time taken to complete the stages of exploratory research on time. To do this, in the theory of the article, a stream of scientific information was appropriately introduced, which changes at each stage. The flow of scientific information can be expressed through useful knowledge for solving the next stage, obtained during the execution of the current one. The results will help to express qualitative indicators of effectiveness and quantitative indicators which are depending on time t.

Keywords: Exploratory research · Velocity movement · Flow of scientific information · Useful knowledge

1 Introduction

Today it is important to reduce the time spent on exploratory research. To achieve this aim, it is necessary to analyze the course of the exploratory research processes, first individually, to identify the strengths and weaknesses. To do this, it is necessary to present the process of the work point movement, first in the form of the mathematical model, and then visualized on a graph. It should be immediately noted that it is for the first time that the authors propose this approach for achieving the aim indicated in the article. The material characterized in the article is a continuation of their scientific work on the research of the exploratory research process.

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2 Theory

Exploratory research process can be represented as a moving point on the plane P_1 or on the graph $P_1(\lambda)$ (Fig. 1). A characteristic of this process can be the motion velocity of the non-material point v. If we consider the movement of the point in the xyz coordinate system, then we need to consider the path from point A to point B along the curve $f(t)$, where. If to calculate v we take into account the displacement of the point along the projection $f(t)$ onto the xy plane, then we need to consider the path from the point A_y to point B along the curve, where $P_1(\lambda) \in P_1$. It is necessary to consider the velocity of such a point as a vector, which is decomposed into components in Cartesian coordinates. Since the law of energy conservation is not taken into account, then, when the point passes from one plane P_i to another plane P_j, the velocity will be calculated again, based on the new prevailing conditions. Such a transition will be instant. The intention to begin the next stage of exploratory research launches a new cognitive process with the found amount of knowledge $\Delta 3$ obtained over time t.

Let us consider an example. Let the transition to the next stage of exploratory research take place at point B - the study of mathematical models [1–3]. The intensity of the event flow, given the equality $x = \Delta t$, is equal to:

$$\lambda = M(3)/\Delta t = \Delta 3_{cp}/\Delta t. \tag{1}$$

Here $M(3)$ is the mathematical expectation [4] of the event of obtaining the amount of knowledge $\Delta 3_{cp}$, and $\Delta 3_{cp}$ is the amount of knowledge identified by the event. Then, considering Eq. (1) the following can be written: $t = t_1$; $3 = \lambda_{ab} \cdot t_1 = n_{cp} \cdot 3$. If the obtained $\Delta 3$ is not enough to complete the current stage, then there will be an instant transition to the desired stage of the exploratory research. It occurs immediately after the problem is fixed and a decision is made to launch a new stage.

The point can move along the planes P_1, P_2, P_3, P_4 and P_5 and from plane to plane in a sequence that may depend on the prevailing external conditions. The model proposed by the authors can take into account various cases: from the ideal to the worst, which can take the longest time t. A top view graphical representation (Fig. 2) of the process of moving the point along these planes can be represented as a curve $f_{xz}(t)$ on the xz plane.

Let us consider the movement along the segment [D; E] of the curve $f_{xz}(t)$ on the xz plane (Fig. 2). This segment of the curve is located on the plane P_i. We can record the following to move the point along the P_i plane:

$$D \notin P_{i-1};\ DE \in P_i;\ E \notin P_{i+1}. \tag{2}$$

Figure 2 helps to get a picture of the general motion of the point from the moment the work begins to its completion, as a projection of the point motion on the xz plane. The figure does not allow to see the transitions from one plane to another. At the moment of transition from the plane P_{i-1} to the plane P_i, point D first belongs to the plane P_{i-1} ($D \in P_{i-1}$), and then belongs to the plane P_i ($D \in P_i$). In Fig. 2, the transition is not visible, since in the top view of the xz plane it is represented by a single point (D). The written Eq. (3) become clear when visualizing the displacement of the point with respect to the final probabilities $P_1(\lambda)$, $P_2(\lambda)$, $P_3(\lambda)$, $P_4(\lambda)$ and $P_5(\lambda)$ on the xy plane.

3 Solution

We obtain the expression for the movement velocity of the point in the dependency graphs $P_1(\lambda)$, $P_2(\lambda)$, $P_3(\lambda)$, $P_4(\lambda)$ and $P_5(\lambda)$ on the xy plane. The velocity vector in Cartesian coordinates:

$$\vec{v} = \dot{x} \cdot \vec{i} + \dot{y} \cdot \vec{j} + \dot{z} \cdot \vec{k}. \tag{3}$$

where $\vec{i}, \vec{j}, \vec{k}$ – single unit vectors.

Next, we consider the motion of the point along the xy plane, which reflects a dependency graph of the final probability P_i on λ in its motion projection. Point velocity is:

$$v_{P_i} = dP_i(\lambda)/dt_x, \tag{4}$$

where $t_x = \dot{x}_t = \lambda$;

$P_1(\lambda) = (1 - \lambda)/(1 + 3 \cdot \lambda)$ – obtained earlier probability [1–3].

We substitute Eqs. (6) and (7) into (5) and obtain the expression for the point velocity along the graph P_1(k):

$$v_{P_1} = \frac{d}{d\lambda}\left(\frac{1-\lambda}{1+3\cdot\lambda}\right) = -\frac{4}{(1+3\cdot\lambda)^2}. \tag{5}$$

Minus in the final expression indicates that the point moves against the y axis, that is, the P_1 axis. It indeed goes down the graph of the final probability $P_1(\lambda)$ or along the plane $P_1(\lambda)$ shown in Fig. 1.

In a similar way, we can derive formulas for the point movement velocities v_{P_2}, v_{P_3}, v_{P_4} and v_{P_5} from the remaining probability plots $P_2(\lambda)$, $P_3(\lambda)$, $P_4(\lambda)$ and $P_5(\lambda)$ [1–3]. The results are given below:

$$v_{P_2} = \frac{5\cdot(1-2\cdot\lambda)\cdot(1+3\cdot\lambda)\cdot(2+\lambda) - 5\cdot\lambda\cdot(1-\lambda)\cdot(7+6\cdot\lambda)}{(1+3\cdot\lambda)^2\cdot(2+\lambda)^2}; \tag{6}$$

$$v_{P_3} = \frac{5\cdot(1-2\cdot\lambda)\cdot[(3-\lambda)\cdot(2+\lambda) - \lambda\cdot(1-\lambda)\cdot(1-\lambda)]}{(3-\lambda)^2\cdot(2+\lambda)^2}; \tag{7}$$

$$v_{P_4} = \frac{5\cdot(1-2\cdot\lambda)\cdot(4-3\cdot\lambda)\cdot(3-\lambda) - 5\cdot\lambda\cdot(1-\lambda)\cdot(6\cdot\lambda-13)}{(4-3\cdot\lambda)^2\cdot(3-\lambda)^2}; \tag{8}$$

$$v_{P_5} = \frac{d}{d\lambda}\left(\frac{\lambda}{4-3\cdot\lambda}\right) = \frac{4}{(4-3\cdot\lambda)^2}. \tag{9}$$

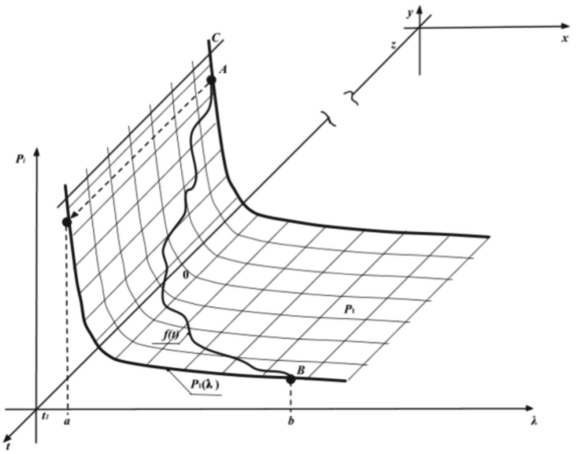

Fig. 1. Moving the point along the plane P_1 in *xyz* space

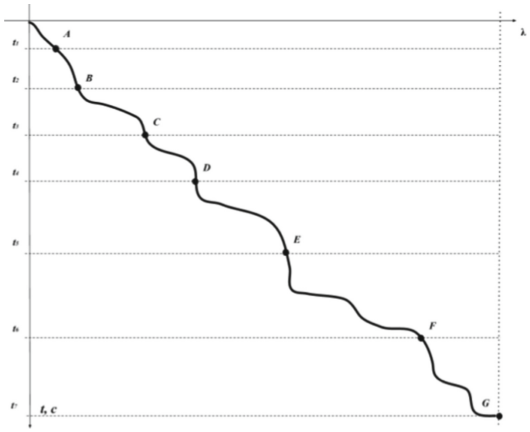

Fig. 2. Top view graphical representation of the process of moving the point along the planes in the form of a curve $f_{xz}(t)$ on the *xz* plane.

4 Results and Discussion

For quantitative assessment and further research, we construct dependency graphs (5)–(9) of the points' velocities movement along the curves of the flow intensity. Let the flow intensity λ change in the interval [0; one]. We substitute λ into the equations and insert the results into the final Table 1.

Table 1. The results of calculations $v_{P_1}(\lambda)$, $v_{P_2}(\lambda)$, $v_{P_3}(\lambda)$, $v_{P_4}(\lambda)$, $v_{P_5}(\lambda)$ and the modules of these values.

λ	$v_{P_1}(\lambda)$	$v_{P_2}(\lambda)$	$v_{P_3}(\lambda)$	$v_{P_4}(\lambda)$	$v_{P_5}(\lambda)$	$\lvert v_{P_1}(\lambda)\rvert$	$\lvert v_{P_2}(\lambda)\rvert$	$\lvert v_{P_3}(\lambda)\rvert$	$\lvert v_{P_4}(\lambda)\rvert$	$\lvert v_{P_5}(\lambda)\rvert$
0	−4	2,5	0,83	0,41	0,25	4	2,5	0,83	0,41	0,25
0,1	−2,36	1,00	0,64	0,56	0,29	2,36	1,00	0,64	0,56	0,29
0,2	−1,56	0,32	0,47	0,62	0,34	1,56	0,32	0,47	0,62	0,34
0,3	−1,10	−0,02	0,31	0,57	0,41	1,10	0,02	0,31	0,57	0,41
0,4	−0,82	−0,21	0,15	0,37	0,51	0,82	0,21	0,15	0,37	0,51
0,5	−0,64	−0,32	0	0	0,64	0,64	0,32	0	0	0,64
0,6	−0,51	−0,37	−0,15	−0,59	0,82	0,51	0,37	0,15	0,59	0,82
0,7	−0,41	−0,40	−0,31	−1,42	1,10	0,41	0,40	0,31	1,42	1,10
0,8	−0,34	−0,41	−0,47	−2,44	1,56	0,34	0,41	0,47	2,44	1,56
0,9	−0,29	−0,42	−0,64	−3,3	2,36	0,29	0,42	0,64	3,3	2,36
1	−0,25	−0,41	−0,83	−2,5	4	0,25	0,41	0,83	2,5	4

Using the data from Table 1, we construct the dependency graphs $v_{P_1}(\lambda)$, $v_{P_2}(\lambda)$, $v_{P_3}(\lambda)$, $v_{P_4}(\lambda)$, $v_{P_5}(\lambda)$ (Fig. 3a) and their modules (Fig. 3b).

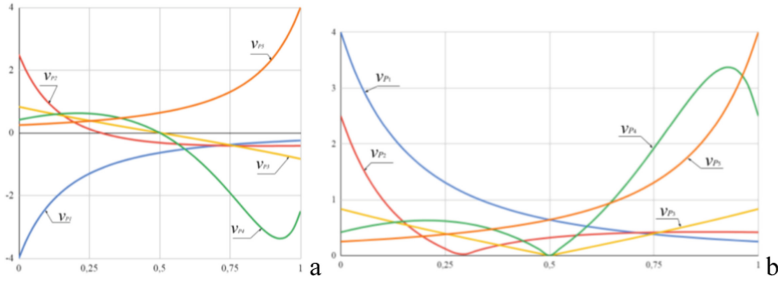

Fig. 3. Dependency graphs of the working point movement

5 Conclusions

The dependency graphs of the working point velocity movement characterizing the exploratory research according to the probabilistic characteristics of each research stage were obtained. A top view graphic image of the point movement process along the planes in the form of a curve $f_{xz}(t)$ on the xz plane was acquired.

The research results will be taken into account when optimizing the exploratory research process. They will help to reduce the time spent on conducting exploratory research. For this, it is necessary to take into account the most productive intervals of the exploratory research stages, paying attention to the values of the obtained work point velocities.

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Artificial Intelligence as Answer to Cognitive Revolution Challenges

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Abstract. Networks and informational technologies caused mammoth growth of knowledge volume and sophistication. Serious cognitive and educational problems of scientific big data understanding have arisen. The part and parcel of coming system-informational culture is inter-disciplinary activity based on labor with meanings ensuring knowledge integrity and obviousness. Presented by the utmost mathematical abstractions they are formed by genus in natural science knowledge. Cogno-ontological knowledge base (CogOnt) as core of these scientific presentations consists of them. Achieving personal transcendentality by means of self-reflection secures cognogenesis success. Man's life-long partnership technology with deep-learned artificial intelligence (DL I_A) is contributed to do it. In order to carry out subject's auto-poiesis (rational self-building) it is impossible to do without continuous assistance of DL I_A using CogOnt and applying axiomatic method. Elaboration of CogOnt for DL I_A implantation is displayed on example of some universalities study.

Keywords: System-informational culture · Deep-learned artificial intelligence · System axiomatic method · Language of categories · Cogno-ontological knowledge base · Universal tutoring · Consciousness auto (self) – building

1 Introduction

System-informational culture (SIC) phenomenology is marked by intrinsic changes in human life. SIC ergonomics deals with cardinal transformation of professional activity that is to be supported in future by deep-learned artificial intelligence (DL I_A) [1–5]. Narrow specialization and work division will be replaced by subjects' universal preparation and their personally social inter-disciplinary labor. Everybody is now drawn in cognogenesis studying electronic thecae. Artificial intelligence (I_A) accompanies already intellectual activity in computer networks imitating human behavior [6, 7]. It helps already to search and browse information. Educational applications and forums complement traditional teaching (T_T). But these program means are marked by subjectivity and constraints proper to their creators. System of T_T is not occupied by people's universal training that reflects world objectivity in all its display. Computer - aided educational superstructure does not essentially change the state of affairs.

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Computer and different mobile devices have become tools of cognition. Inter (trans) - disciplinary labor in SIC needs universally educated person. Coming cognitive revolution has exposed this educational crisis. It can be resolved only in partnership with DL I_A. Universal tutoring is able to untwist person's intellectual processes due to human complexity. DL I_A will apply contributed model of natural intelligence (I_N) in SIC.

Participating in cognitive - research processes man must answer to challenges of this essentially sophisticated rational culture. T_U corresponds to normal rational trend in natural sciences development. Ensuring man's auto-poiesis is main challenge of modern cognitive revolution. DL I_A will help adaptively to a person to repeat anthropogenesis. Knowledge of philogenesis laws allows implanting DL I_A with the help of universal core of knowledge – cogno-ontological knowledge base (CogOnt) [1–5]. An example of DL I_A - I_N cooperation is given where one of universal concepts is descripted and investigated with the help of system axiomatic method.

2 Natural Intelligence Model in SIC

Problem of DL I_A creation leans on model of human being existence in sophisticated rational culture. In SIC I_N has next features. Subject must possess synoptic view on natural sciences (K_N) achievements. Being humanitarian from birth one senses truth of life. Intuitive objectivity (consciousness) is insufficient in system world. Person must not only understand K_N but have mind tools for work with it. Personal K_N presentations must overcome humanitarian "numb of clearness" and disability for constructive work with SIC meanings. In its turn, K_N illness is excessive discursiveness and algorithms usage which are to be also cured. Reasonable synthesis of humanitarian and rational origins can be secured by super natural knowledge SK_N – mathematics, informatics, and programming. Person must develop his life processes scope contrapuntal to SIC. For entering hermeneutic circle [3] corresponding tuning can be based only on rational consciousness self-building with the help of universal essences. This entelechy is to be maintained by possible interactive adaptation to I_A. SIC reality consists of semantic meanings abandoned by men. It is time to return to the reality thus improving mind ecology as question of future human existence. Attaining intellectual transcendentality has become direct problem of education in SIC [3]. Personal adaptive environment of semantic meanings – working place (WP) is to be created in order to cherish and grow up universal ideal abstractions. Being ontological they can be perceived by everybody if proper education is applied. I_N auto-development can be secured and controlled by self-reflection on WP initiated by life-long tutoring partner DL I_A. Due to I_N self-development the same neuro processes of reasoning will embrace higher levels of meanings.

3 New Cognitive Revolution

Humanitarians' believes on "feeling" of sophisticated K_N are doomed to failure. Only sensitive apperception does not lead to understanding. It does not give intellectual tools for concise knowledge investigation. Only mind transcendentality and corresponding endeavors to achieve it allow coping with universalities problem solution. In partnership with DL I_A man will be able to master philogenetic achievements and evolve them in practice [1–5]. By means of T_U meanings will "converge" to man. Providing mind adaptive rationalization DL I_A will maintain subject's cognitive processes. Meanings will be explained and understood by their identification [8], display, and study [1–5]. DL I_A is predestined to education humanization with the help of rational means.

Previous cognitive revolution was connected with printed book issue. It sprang up as tool of knowledge exchange and propagation. In industrialization era problem of knowledge complexity was resolved by means of labor division and education specialization. As outcome man's scope of world was narrowed by T_T. It engendered also static professional presentations. Scientific discoveries caused essential changes in Gutenberg's galaxy. SIC coming accelerated cognogenesis. Inter-disciplinary activity requires now universal education [2, 3]. Scope of life processes is needed to comprehend excessively sophisticated knowledge. Computer networks phenomenology facilitated communication. Super computer (SC) calculations can reinforce DL I_A to transform it in powerful tool of world cognition. Man's complexity has not yet been used in full measure. Subject's rational abilities are required now in order to study systems laws. Purity of intellectual activity happens on the level of general categories (Kant). Easy access to SBD files does not mean their perception. Comprehension happens by personal intellectual breaks that can be attenuated due to continuous assistance granted by deep-learned partner [1]. Every SIC subject must transit from sensitive presentations about third world to their rational explanation on the base of the utmost mathematical abstractions, see Fig. 1. It is SC DL I_A that can ensure world objective subjectization.

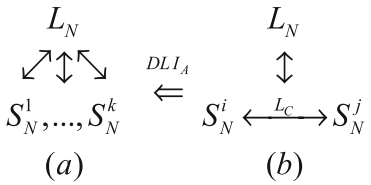

Fig. 1. Mind ecology restoration: from (a) – humanitarian apperception of sciences $S_N^1, \ldots, S_N^k$ in natural language (L_N) to (b) – SBD synthesis in language of categories L_C.

Example 1. In natural language (L_N) group G is defined as algebra having such multiplication operation that for all $g, h \in G$, any equation $gx = h$ or $xg = h$ has unique solution. In L_C group G is one-object category which elements $g \in G$ are simultaneously epi - and mono – morphisms: $g \to hg, g \to gh$ [9, 10]. This description immerges groups in the unity of different categories admitting their comparison. Group

is particular case of semi-group which can be singled out and recognized among them by the next property. There are at least one right unit and one right inverse element g^{-1} for all $g \in G$ [11, 12].

4 Universal Tutoring

New informational technologies reinforce T_T by means of integrated context [13], visualization, and propeudevtic courses usage maintaining knowledge synthesis [14]. But T_T sacrifices discursive reasoning to sensitive apperception. It does not even pursue the aim of student's sophistication being unable to overcome up-to-day educational crisis. Interdisciplinary activity is based on universal ontological essences. Mind does not produce tricks (Hilbert). In view of meanings sophistication continuous universal education (T_U) supported by life-long tutoring partner is needed [3]. It became insufficient for man's work to be confined to calculations. T_U aim is to develop modeling abilities. System AM mastering gives possibility to apply different algebraic systems for abstract types of data (ATD) computer realization. Then knowledge can be applied to discover new one. Only DL I_A can continuously and tirelessly assist man in semantic work with growing richer knowledge. Adaptive help allows humanizing inevitable intellectual breaks to carry into effect under cognition. Only DL I_A can support the labor.

Corresponding technology leans on principal of knowledge without premises assuming form of system axiomatic method (AM_S), meta-mathematics, and powerful semantic languages [5, 9]. They secure DL I_A functionality uniting for the present separated discursiveness - thinking and consciousness - intuitive objectivity. Human sophistication occurs with the help of mind equipping with suitable linguistic tools [9, 15]. Genus has discovered mathesis universalis – language of categories (L_C) [9, 10]. It allows presenting universal abstractions in clear geometrical form of commutative diagrams. It helps to meanings identification [8, 9], extraction, and study. L_C is functional language of second order. It stipulates its great expressive possibilities and constructive work on the level of objects properties. Category view ensures strict meta-mathematical investigation. Even logical inference can be studied under comparative analysis of T_U [10].

Understanding as knowledge self-obviousness can be achieved only on the way. T_U will support cognitive revolution in SIC leaning on CogOnt usage. The functor transforms SBD into super natural mathematical form. It can be realized as an open system taking adaptive form PCogOnt on personal intellectual WP. Due to I_N – I_A cooperation current intellectual state of a person is conserved in the form of rational minutes for K_N adaptation. It is result of arising communication contexts [2]. System AM serves to knowledge factorization by meanings and its inclusion in CogOnt [1].

5 Technology of Partnership with DL I_A

Transcendental mathematical abilities are base of universal presentations about metrical properties of space. Geometry was created in the process of long historical development. Geometrical constructions and measurements selected basic geometrical abstractions – point, line, circle, triangle, rectangle, regular bodies. Euclid's geometry expressed constructive possibilities of compasses and a ruler in axiomatic form. The study overcame irrationalities problem arisen in proportions theory by means of the field Q needed algebraic extensions. It was the ideal of those times that has become the reality in ours. Descartes' coordinates supported geometry study by new ideal algebraic tools. Hilbert's modern AM applied independent axioms to give freedom to geometrical considerations [16], see Fig. 2. By means of segments calculus Hilbert substantiated not only Euclid's geometry but constructed new ones. Real line R was also built. Linear algebra gives now ideal presentation for Euclid's geometry. It makes possible to regard on points as vectors and constructions – as linear operators action.

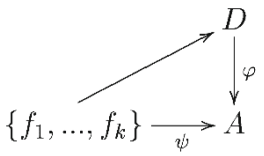

Fig. 2. If free object $D \simeq A$ then $\psi(f_i) \in A, i = 1, 2, \ldots, k$, are independent.

The distance $\rho(A, B)$ between two points is defined as vector AB norm. In vector language Pythagoras' theorem states that if scalar product $(a, b) = 0$ then $c^2 \equiv (a+b)^2 = a^2 + b^2$. So as quadratic form $F : V \to R$ is used the approach can be applied not only to plane but to every multi-dimensional vector space V.

Example 2. *Quadratic forms fundamentality.* Metric $\rho : V \times V \to R$ in Euclid's space can be introduced by positively defined quadratic form $(F > 0)$ for which sets $epiF \subset V \times R$ and $\{0\}$ are separated by a hyper-plane. Associated with F bilinear form (u, v) helps to choose orthogonal basis. In finite-dimensional space $V \simeq R^n$ it allows reducing every form F to the sum of independent squares $F(y) = a_1 y_1^2 + \ldots + a_n y_n^2$, see Fig. 2. Infinite-dimensional forms are also used, for instance, in variation calculus.

The simplest presentation of quadratic function $F = I, V = C^1[a, b]$, contains functionally dependent variables y, y' that impels to apply other methods of their study:

$$y \to I(y) = \int_a^b \left(y^T P(x) y + y' S(x) y'\right) dx.$$

The form can be the second variation $I(y) = \delta^2 J, y = \delta v$, of the given criteria J in a point v^*. Condition $P, S > 0$ is sufficient for I positive definiteness in the whole space V that is near to the necessary one. If $\delta J(v^*) = 0, \delta^2 J(v^*, \delta v) > 0$ then v^* is local minimum of the map J. In variation calculus problems with fixed boundaries this

property is to be studied in subspace $y(a) = y(b) = 0$ of V. Jacobi proved that strong convexity of the map is satisfied if $S > 0$ and there are no points conjugate to a on semi-segment $(a,\ b]$. In optimization theory linear algebra gives stability to the presentations.

Concepts formation happens by means of different theories interaction on the basis of universalities. Geometric notions are enriched by algebraic ones and vice versa:

$$k = \frac{a}{b} = \frac{c}{d}(a, b, c, d \in Q) \Leftarrow y = kx(x \in R) \Leftarrow y = (u, v) \Leftarrow \ \rho = |u|(u, v \in V).$$

6 Conclusions

Cognition is continuous world creation with the help of languages productivity. Person's rational self-building strengthens thinking by language of categories. Communication is to be also risen on semantic level needed for interdisciplinary personally social work in SIC. Labor with semantic meanings encourages self-reflection and transforms the ideal in the real and vice versa. DL I_A is to put them at person's disposal by means of PCogOnt and AM application. DL I_A universal tutoring allows helping forward modern cognitive revolution. In partnership with I_A mind ecology will be restored and I_N life-scope is synthesized. Contributed technology will assist mankind to achieve at last the highest evolutional level. It will be natural result of modern cognitive revolution.

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Continuous Control in Deep Reinforcement Learning with Direct Policy Derivation from Q Network

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Abstract. The reinforcement learning approach allows learning desired control policy in different environments without explicitly providing system dynamics. A model-free deep Q-learning algorithm is proven to be efficient on a large set of discrete-action tasks. Extension of this method to the continuous control task usually solved with actor-critic methods which approximate a policy function with additional actor network and uses Q function to speed up policy network training. Another approach is to discretize action space which will not give a smooth policy and is not applicable for large action spaces. A direct continuous policy derivation from the Q network leads to optimization of action on each inference and training step which is not efficient but provides optimal and continuous action. Time-efficient Q function input optimization is required in order to apply this method in practice. In this work, we implement efficient action derivation method which allows using Q-learning in real-time continuous control tasks. In addition, we test our algorithm on robotics control tasks from robotics gym environments and compare this method with modern continuous RL methods. The results have shown that in some cases proposed approach learns smooth continuous policy keeping the implementation simplicity of the original discreet action space Q-learning algorithm.

Keywords: Reinforcement learning · Q-learning · Continuous control · Robotics · Deep learning

1 Introduction

Reinforcement learning as one of the three general machine learning paradigm allows learning goal-based policy without explicit task dynamics knowledge by means of trials and errors. The reinforcement learning paradigm includes the following basic concepts: environments, agent, observation, reward, and action. An agent acts in the environment, choosing the actions based on observations, maximizing discounted cumulative reward formalized by bellman optimality principle [1]. The goal of the learning is to obtain a mapping from observation to action, known as a policy function.

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The reinforcement learning paradigm is proven to be efficient for a large set of tasks. For instance, RL as a method for optimizing non-differentiable loss function is capable of improving neural machine translation algorithms, review by Wu et al. [2] Besides NLP task, RL is also capable to provide end to end solution for vision-based autonomous driving [3]. In robotics, RL successfully applied on number of continuous control tasks. For example, the work called Learning Dexterous In-Hand Manipulation demonstrates pre-training in simulation and knowledge transfer to reality for efficient goal-oriented robotics hand control. [4] Tasks mentioned above imply continuous control signals, thus classified as continuous control tasks which are common in the real scenarios.

Q-learning [5] is one of the possible Reinforcement Learning paradigm implementation. Q-learning is model-free algorithm; thus, it does not require a predefined model of the environment in order to learn efficient behavior. The goal of Q-learning is to learn action-value function or Q function. Q function outputs expected discounted reward for specific state and set of possible actions that allow deriving a policy be selecting the action with the maximum Q value. Typical Q learning approximator illustrated on Fig. 1a.

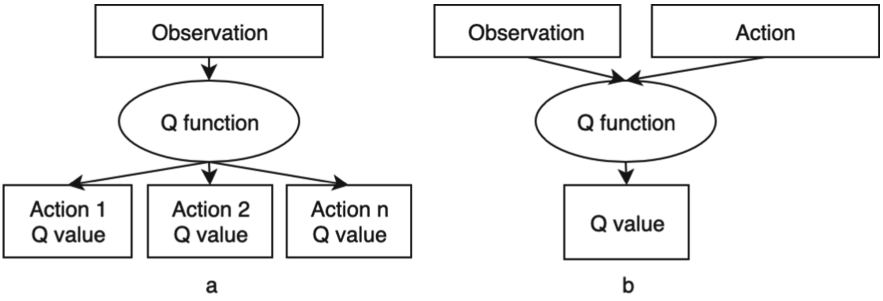

Fig. 1. Q function implementations. a – Discrete action Q function, b – Single output Q function (DPDQN)

Actions and observations are classified into discrete and continuous. If both action space and observation space are discrete, the policy can be described as a table which maps states to finite actions. However, if the action space is continuous or state space is large, an appropriate approximation of policy function needs to be used. In the deep Q-learning algorithm [6], deep reinforcement learning successfully applied on the Atari game task with deep neural network with the input of the raw pixel, by means of optimization techniques combination such as fixed target network and experience replay.

Q-learning could be extended to the continuous control domain in various ways. The simpler option is to quantize continuous space, which is infeasible and inefficient in some cases and lead to expansion of action space. The most common approach, for instance, used in DDPG algorithm [7], implies the utilization of Q-function to train separate policy networks.

In this work, we consider pure deep Q-learning method with state-action input and single-action value output shown in (Fig. 1b). This Q network architecture allows us to work with a continuous state-action domain. However, we can't apply argmax function to select the most appropriate action in each state, instead of to select optimal action on each iteration we need to apply optimization to find network input which maximizes the output of Q function. In contradistinction to simulated environments where we can freeze time for policy execution, in some cases it is impossible for production environments where we need to select optimal action in real-time with limited delay. However, some techniques could be applied in order to make this process more efficient.

In this project, we implement the algorithm which we call Direct Policy Derivation Q-Network (DPDQN). Our paper provides two main contributions: first, we provide efficient DPDQN implementation which is capable to solve general continuous RL problems provided by OpenAI gym environments [8]. Second, we compare our implementation sample efficiency and training performance with modern RL baselines [9] for continuous RL tasks [8]. We show that the idea behind DPDQN is viable and can compete with modern RL algorithms. The source code and results of our research available on GitHub [10].

2 Method

2.1 Q-learning Background

In general, DPDQN is a common deep Q-learning algorithm with experience replay [5, 6] and thus, it is important to mention Q-learning principles in order to describe details of our implementation.

DQN [6] uses experience replay buffer to collect samples from observations of agent actions and reward. Experience dataset is used to train Q network with Temporal difference learning on each algorithm iteration, which is mean squared error between actual experience and opinion of Q network about reward outcome [6].

Training achieved by trials and errors, in the case of Q-learning exploration of new behavior based on artificial probability of making random action controlled by ε hyperparameter. Exploration decay or adaptive exploration can improve training efficiency shown by Tokic, Michel [11].

2.2 Method Description

For DPDQN, action derivation from q network, network architecture, and exploration method are main differences from the original Q-learning algorithm. We use the observation-action input function approximator (Fig. 1b) to deal with continuous action vector. Exploration control derived from the action selection algorithm.

We use the two-mode process to derive policy from Q function. For training mode, we generate a set of random action candidates from environment action space. Later, we generate input tensor merging a set of states and action candidates, which allows us to compute Q values in batch mode. The action with the maximum Q value is selected for the next step. By changing the number of random actions, we can control our exploration rate. We apply exploration rate decay and linearly increasing the number of actions to stabilize training. The initial number of actions and the number of actions for the final step are hyperparameters of our algorithm. By selecting random actions, we achieve exploration and avoid optimization of Q function during training.

For exploitation or greedy mode, we need to select the action which maximizes the output of Q function. As the first step, we repeat the same sampling process as for exploration. The chosen action latter is optimized with a gradient descent algorithm. We used PyTorch [12] framework to model our neural network. We can fix network parameters and state input, and at the same time unlock gradient computations for action input to apply automatic differentiation module for action optimization. Each gradient descent step requires forward and back pass through the network and thus it is a costly operation, however, we have only one active input, which makes this process fast enough to apply in real-time. We can control this process by limiting the number of optimization iterations and learning rate hyperparameters. This process allows us to derive near-optimal action with controllable performance, which makes DPDQN semi-deterministic algorithm applicable for continuous control tasks.

3 Experimental Results

In order to evaluate results, we applied modern algorithms from OpenAI baselines collection [7] on "gym" environments [8]. We compared DPDQN with the following algorithms: SAC [13], TD3 [14], A2C [15], and PPO2 [16]. For all of these algorithms, we did not optimize hyperparameters and used only pre-defined.

We selected three different continuous control tasks with different complexity from the "gym" package: Pendulum-v0, LunarLander-v2, and BipedalWalker-v2. For instance, in BipedalWalker-v2 agent should control motor torques and perceiving the environment through sensors such as hull angle speed, angular velocity, horizontal speed, vertical speed, etc. The reward is given for successfully moving forward and lost if the robot falls.

To make the comparison equally fair, we limit the number of available training steps to 1000000 which is equal approximately to 1700 runs or iterations for the robot walker environment. We provide trained model performance comparison in (Fig. 2) and training process-visualizations in (Figs. 3 and 4).

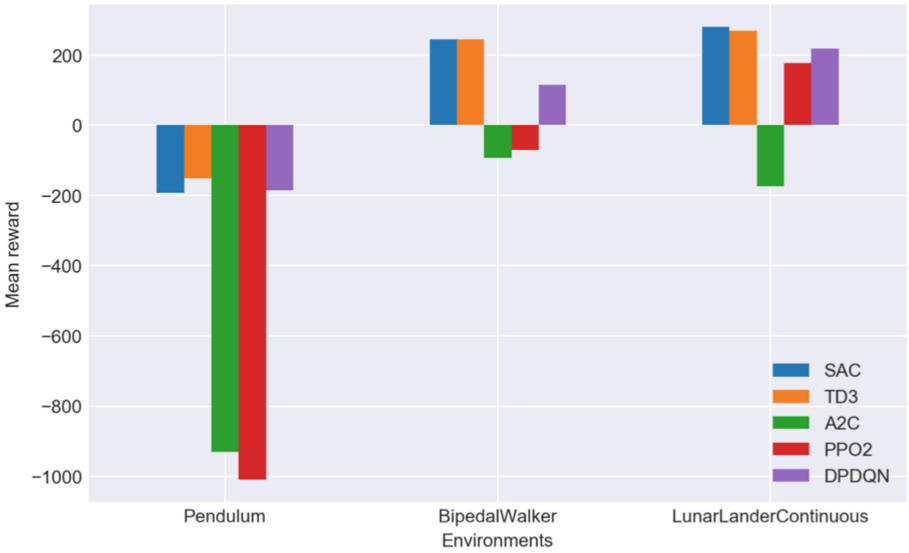

Fig. 2. Algorithm performance comparison

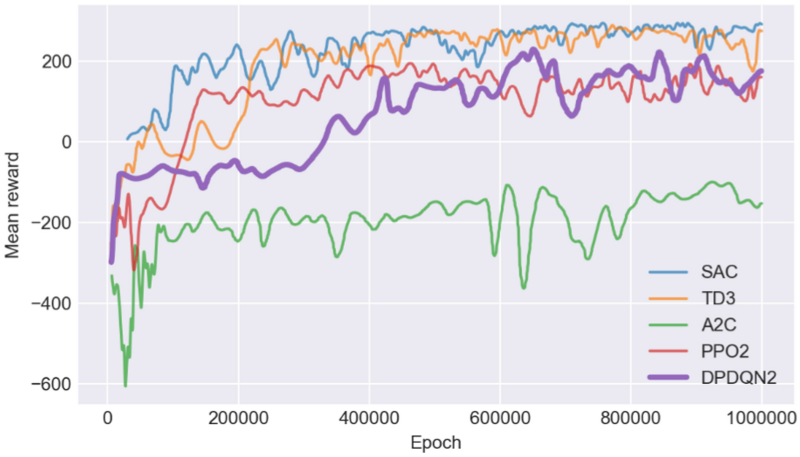

Fig. 3. Training process for Lunar Lander task

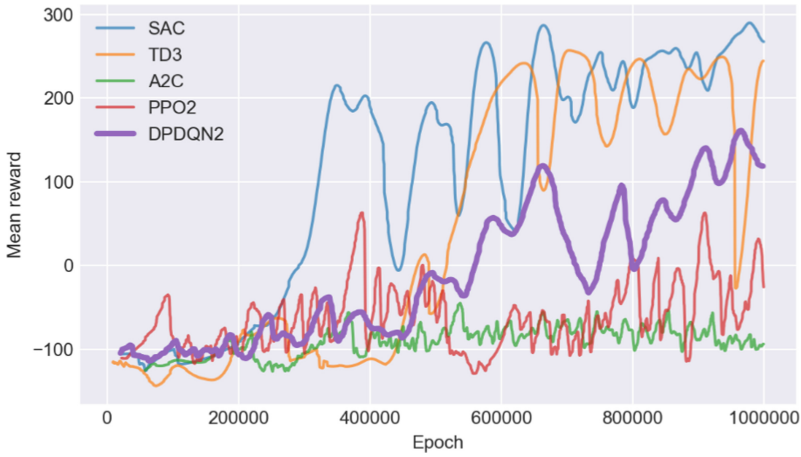

Fig. 4. Training process for Bipedal Walker task

4 Conclusion

In this work, we implemented a continuous version of the Q-learning algorithm. Evaluation results showed us the potential of the method. The technique we propose allows learning efficient policy for continuous control tasks. We provide an efficient implementation of policy derivation from the Q network. Performance and sample efficiency of this method is demonstrated in common RL environments and compared with state-of-the-art methods. Further, we plan to test this method on more complex continuous control tasks such as robotics manipulators and self-driving cars. In addition, we have plans to apply modern DQN extensions such as double Q learning to improve our method efficiency.

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Research on Cooperative Operation of Air Combat Based on Multi-agent

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Abstract. The cooperative operation of soft and hard weapons is very important in air combat. Firstly, aiming at the distributed and intelligent characteristics of soft and hard weapons in air combat, multi-agent technology with autonomy, distribution and collaboration is introduced. Secondly, the cooperative operation agent model of soft and hard weapons is constructed by applying the theory of distributed hierarchy. The combat capability of soft and hard weapons is abstracted and formalized. Finally, adopting the reinforcement learning mechanism, the judgment, fusion and decision-making process of each agent can be guided to achieve the predetermined target. The method of resource allocation and optimization of soft and hard weapons are explored in the paper to provide theoretical support for hard and soft weapons cooperative operations of air combat. A simulation example is illustrated in the end and the simulation result shows that the method is effective.

Keywords: Weapon agents · Cooperative operation · Hard and soft weapon resource · Distributed hierarchy · Reinforcement learning mechanism

1 Introduction

With the rapid development of modern science and technology, the future air combat environment will become more and more complex. In the process of confrontation, it is necessary to give full play to the comprehensive advantages of hard and soft coordination in time domain, airspace and frequency domain, to destroy and interfere with targets as much as possible, to preserve itself, and to get greater initiative [1, 2]. Soft and hard weapons are not only battle output terminals, but also intelligent nodes that can feedback process control and provide assistant decision-making information support. Document [3] introduced agents into the target assignment of ship air defense. Document [4] used the historical behavior of other agents as a training set to learn, but this algorithm is poor to priority learning in robustness and cannot deal with inconsistent historical behavior of agent. This paper explores the application of soft and hard weapons in air-to-air combat cooperative operation using multi-agent technology.

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2 Operational Characteristics and Agent Description of Soft and Hard Weapons in Air Combat

2.1 Operational Characteristics of Soft and Hard Weapons in Air Combat

There are many kinds and quantities of soft and hard weapons resources used, and the operational capability of various weapons is different. The agent model reflecting the operational capability is established to provide technical basis for optimizing weapon resource allocation, formulating operational plan and coordinating weapon compatibility. In air warfare, hard weapons such as medium and long range air-to-air missiles and short range air-to-air missiles are usually used in combination with soft weapons such as active and passive electronic countermeasures and detection systems such as radar and optoelectronics to establish a multi-level air combat system with complementary hard and soft, as shown in Fig. 1.

2.2 Weapon Agent Description of Hard and Soft Weapon of Air Combat

Multi-Agent-based modeling method is a top-down analysis, bottom-up synthesis modeling method, to study the dynamic characteristics of the system. This method combines the micro-behavior of complex system with the macro-emergence phenomena. It uses the attributes and behaviors of each agent to depict the interaction and sociality of agents and to study the overall behavior of the system. Compared with traditional modeling techniques, this method has obvious advantages in flexibility, hierarchy and visualization. It is suitable for modeling the complex system of war. The modeling process is divided into four steps: requirement analysis, agent identification, agent description and multi-agent cooperation model.

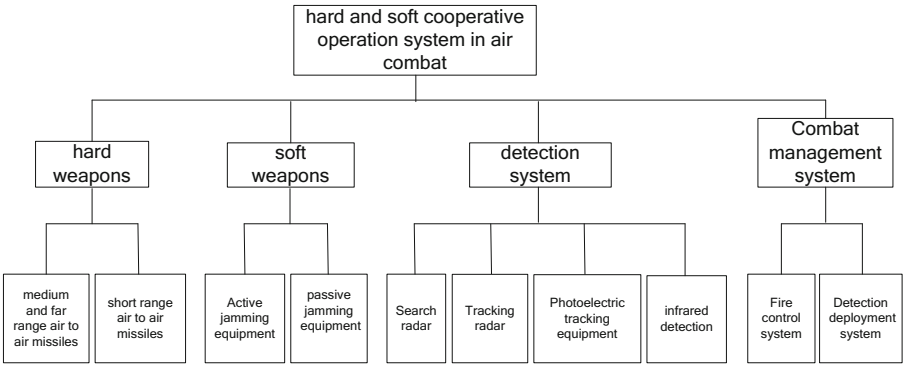

Fig. 1. Hard and soft cooperative operation system in air combat

3 Research on Soft and Hard Weapons Cooperative Operation Based on Agent

According to Saridis's hierarchical thinking, the air combat system is divided into three levels: organization level, coordination level and execution level. According to the principle of "Accuracy decreases with increasing intelligence", the control and management tasks are allocated in different levels [5, 6]. This paper combines the natural division of distributed control system with the hierarchical division of intelligent control system. Based on the idea of distributed hierarchy, the architecture of agent system for hard and soft weapon cooperative air combat as shown in Fig. 2 is constructed. Intelligent algorithm is used to integrate the independent behavior of soft and hard weapons into swarm intelligence. Jointly complete the coordinated operation of soft and hard weapons, giving full play to the overall intelligence advantage.

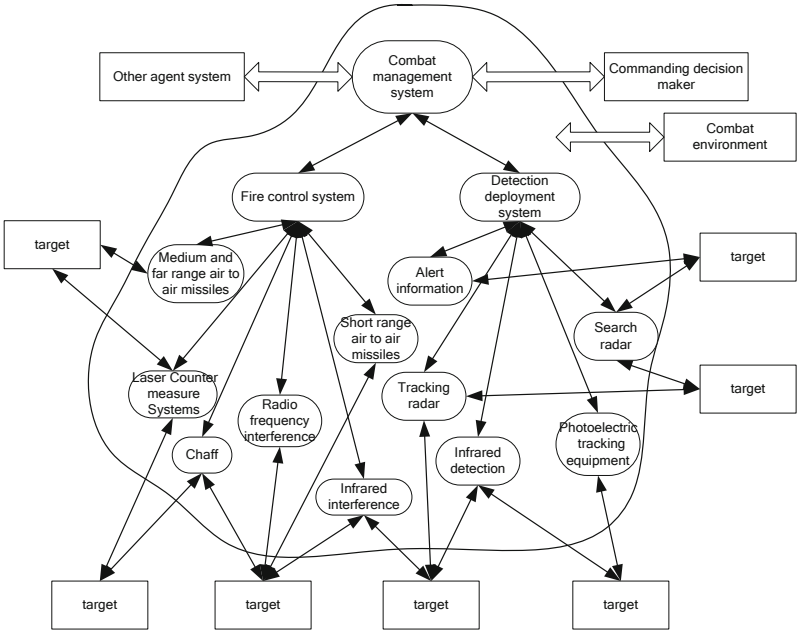

Fig. 2. Agent system structure of hard and soft cooperation in air combat

The Multi-agent model of air cooperative combat established in Fig. 2 was analyzed by simulation. Under a certain attack and defense situation, both sides of the enemy and the enemy make full use of various means of detection, interference, long range air-to-air missiles and short range air-to air missiles. Through reinforcement learning, a cooperative operation plan with optimal combat effectiveness is obtained, as shown in Fig. 3.

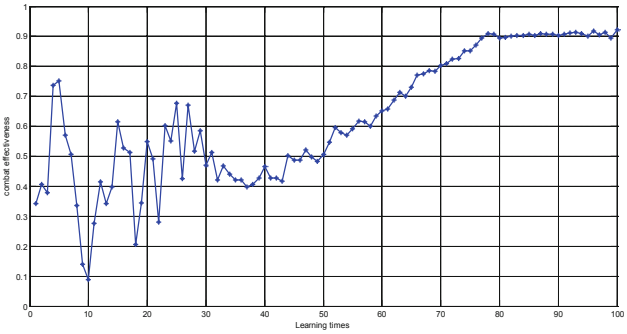

Fig. 3. Simulation result

The simulation result shows that the method is effective, after the initial oscillation, the system's comprehensive operational effectiveness tends to be stable through reinforcement learning. At the same time, the hard and soft cooperative operation plan is the best one.

4 Concluding Remarks

Agent technology as the latest research results in the field of artificial intelligence has attracted more and more extensive research interest, and its application is rapidly expanding in various fields. The complexity of the cooperative combat process of air combat soft and hard weapons makes it difficult to describe them accurately by traditional macro-model research methods. Agent technology provides a better solution for the research of soft and hard weapon systems. Agent technology is used to construct cooperative combat scheme generation system, which basically reflects various wartime characteristics such as battlefield environment, equipment performance, combat principle, combat style, combat object, combat coordination and combat means. It can provide theoretical support for further research on cooperative combat of soft and hard weapons in air combat. Although agent technology has made great progress in recent years, it is still in the stage of exploration and research, far from being mature, but it does show great potential application value, which is worthy of our in-depth study and research.

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Traffic Sign Classification Using Embedding Learning Approach for Self-driving Cars

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Abstract. Image classification is one of the most popular and important problems in computer vision. In self-driving cars image classification is used to classify detected traffic signs. Modern state-of-the-art algorithms based on deep neural networks use softmax function to interpret the output of the network as the probability that the input data belongs to a certain class. This approach works well, however it has several disadvantages. More precisely, it is necessary to know the number of classes in advance, and if one wants to add a new class, then it is necessary to retrain the network. Moreover, a large number of images of each class are required. In the case of road signs, datasets may contain only the most frequent signs while ignoring rarely used ones. Thus, the traffic signs recognition module in autonomous cars will not recognize traffic signs not included into training dataset, which can lead to accidents. In this paper we put forward another approach that does not have disadvantages of networks with softmax. The approach is based on learning image embeddings in which models are trained to bring closer objects of one class and to move away objects of other classes in embeddings space. Therefore, having even a small number of images of rare classes it becomes possible to create a working classification system. In this work, we test the applicability of these algorithms in the traffic signs classification problem, and also compare its accuracy with neural networks with softmax and with networks pre-trained on softmax. We developed publicly available toolbox for training and testing embedding networks with different loss functions, backbone models, training strategies and other configuration parameters and embedding space visualization tools. All our experiments were carried out on the russian road signs dataset. To simplify the process of conducting training experiments, a framework for embedding learning based neural networks making was created. The framework can be found at https://github.com/RocketFlash/EmbeddingNet.

Keywords: Deep learning · Self-driving cars · Traffic signs classification · Robotics

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1 Introduction

Today there are a large number of deep neural network architectures to solve image classification problem [1–4]. Most of these networks have a softmax function on the last layer and use categorical cross-entropy as a loss function. The softmax function converts the network output into a probability vector, each value in which shows the probability of belonging to a particular class. The number of classes in this case is fixed at the beginning of training, and if there is a need to add a new class, it is necessary to retrain the network.

Another approach to image classification is to use embedding networks. They are able to convert input data into d-dimensional vector, in other words to a point in dimensional space. Such network learns to pull together objects of one class and move objects of different classes away in the embeddings space. Examples of such networks are siamese networks [5, 6], and triplet networks [7, 8]. Siamese networks take two samples as input (same class or different) and output how similar they are. While triplet networks take three samples as input (anchor, positive and negative samples) and do the same. Trained networks are able to transform input data to a point in embeddings space that can be processed using classical algorithms such as kNN, SVM, clustering algorithms etc. The approach is very similar to the classical computer vision approach for classification such as Haralick [9] or another image descriptors, however features in embedding learning approach are found using neural networks, rather than being handcrafted.

One of the main advantages of above described network is that not only do we get a classifier, but also an embeddings space in which we can calculate how similar classes are. Moreover, there is no need to retrain the network when new classes are introduced and its training does not require a huge amount of data. Owing to these advantages these networks are often used to develop a face recognition system. However, embedding networks are harder to train because the network can fall into a collapse state (a state where all input data collapses to the same point). To avoid this problem, various data selection strategies are used, such as hard negative mining, semi-hard negative mining etc. [10].

2 Methodology

2.1 Dataset

For training and testing networks we used RTSD (Russian traffic signs dataset) [11]. The dataset contains images that were shot at different weather conditions (rain, snow, bright sun etc.) and at various times of the day (morning, day, evening). The total number of images in the dataset (126637) were divided into 107 classes, each class having different number of images. In our experiments only 5743 images from 100 classes were used. Selected data was divided into training and validation sets (30 images from each class for training and remaining data for while leaving the remaining for validation. Images have different sizes, so we resize them to ($48 \times 48 \times 3$). Figure 1 shows sample data from RTSD. Remaining classes had less than 30 images, so we left them to test the

network in the image classification of objects that were hypothetically absent at the training stage.

Fig. 1. Example images from RTSD dataset

2.2 Network Architectures

For experiments, we chose three types of architectures: TripletNet, SoftTripletNet (TripletNet pretrained on softmax) and SoftmaxNet (softmax based network). All the architectures used pre-trained on Imagenet ResNet18 network as backbone model with input size ($48 \times 48 \times 3$). TripletNet uses triplet loss as loss function and its last network layer contains 256 values (dimensionality of embedding space). L1 distance was selected as a metric for embeddings distance calculation. Also we used L2 normalization for output embeddings. SoftTripletNet has the same architecture, but at the beginning of training, the softmax layer was attached to the last layer and for several epochs network was trained using categorical cross-entropy loss function. SoftmaxNet uses softmax layer as output layer and categorical cross-entropy as loss function.

2.3 Training

For all experiments RAdam optimizer [12] was selected as an optimizer for training and initial learning rate was 0.0001. We used several learning rate decreasing callbacks such as learning rate scheduler with decay factor 0.95 and reduce learning rate on plateu. For TripletNet and SoftTripletNet used semi-hard triplet mining approach as a triplet choosing method. SoftTripletNet was pre-trained 10 epochs using softmax layer.

3 Experiments and Results

We conducted several experiments to test the applicability of embedding learning networks to solve traffic sign images classification problem. We performed comparative analysis of the classification accuracy and inference time of all architectures (Table 1 shows the experimental results). SoftTripletNet showed the best results in top-1 and top-5 accuracies while SoftmaxNet showed the best result in terms of speed. Although inference time of SoftTripletNet and TripletNet can be accelerated, for example, if we consider the distances not to each object in embeddings space, but to the centers of the classes in embeddings space. Figures 2 and 3 show t-SNE plots of images in embeddings space before and after training. As can be seen from the plots, SoftTripletNet is better at grouping objects into classes than TripletNet. Next, we used a trained SoftTripletNet to predict 7 remaining classes from the dataset that were not present at the training stage. Despite the fact that the network was not trained at these remaining classes, it showed prediction accuracy 0.9629.

Table 1. Results of experiments

Architecture	Top-1 accuracy	Top-5 accuracy	Inference time
TripletNet	0.9188	0.9409	0.00648
SoftTripletNet	**0.9493**	0.9657	0.00652
SoftmaxNet	0.9475	0.9601	**0.00588**

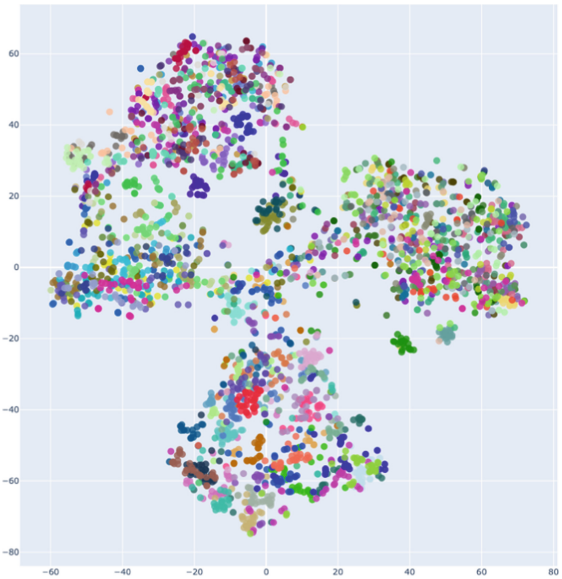
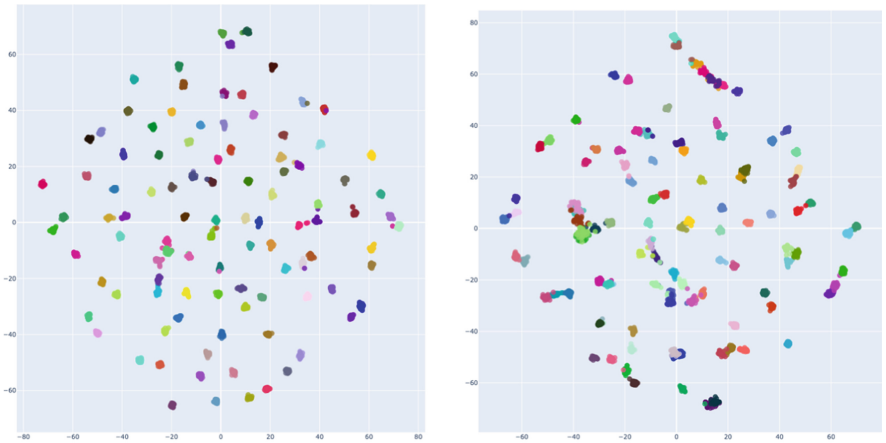


Fig. 2. t-SNE plot of embeddings from TripletNet before training



(a) **(b)**

Fig. 3. t-SNE plots of embeddings from (a) trained SoftTripletNet, (b) trained TripletNet,

4 Conclusion

In this work we implemented framework for training, testing and working with embedding learning based deep neural networks. We conducted several experiments to understand how well embedding learning based networks are suitable for solving traffic sign images classification problem. The experiments showed that the use of TripletNet with softmax pretraining improves recognition accuracy and allows to obtain embeddings space in which it becomes possible to make predictions without network retraining.

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Emergency Case Report Application Applying Location Based Service Framework on Mobile Smart Devices

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Abstract. People in Thailand always rely on a calling channel using tele phone. 191 is as an official number to get assistance when a critical or emergency case happens e.g. accident, crime, medical issue and robbery. However, calling channel operated by officer cannot retrieve caller's location information automatically. The best clue is caller's cell site or base station where the caller is when they are making a contact. Moreover, many cases that callers do not know exact location where they are or sometimes they have inaccurate position information i.e. wrong street name or wrong address. Then, emergency dispatch team may not be able to arrive at the right location efficiently on time. This work applied Location Based Service framework (LBS) to develop an Android mobile application used for reporting critical and emergency case to the authorized officers. Users can select assistant topic or incident case and request for relevant dispatch team on demand. This application will send geolocation information automatically to the officer how to reach out the reporter via road map navigation system. This application also provides several statistics and reports. This mobile application also helps to prevent false or pranking report because a lot of user's information will be provided automatically to the authorized officer e.g. IP address, GPS location, and cell phone number. These unique pieces of information will make user realize how serious this report is and avoid making a prank report for fun.

Keywords: Emergency case · Incident report · Dispatch team · Location Based Service · Android · Mobile application · Firebase · Google Map

1 Introduction

To protect people's lives or properties from emergency cases i.e. accident, early stage of warning and immediate responding to the reporter are playing a very important role. This concept has been widely adopted for national and local government [1]. Most cases that ending with tragedy, loss of lives due to late delivery of the dispatch team caused by different factors i.e. too late report, missing of vital information, and insufficient report channel. Call-processing time is another factor to evaluate the effectiveness of the calling channel [2]. However, partial correct information given by the caller via telephone may affect the precision of this reporting method. In Kenya,

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there were a lot of road accidents happened. However, the official channel to report this incident was not convenient and lack of performance [3]. The result was most cases went under notice by the authority or turned in to hit and run cases. Then, adopting and applying new technologies to report and request for emergency assistance via smart phone is cable of alleviating these serious problems. Especially, healthcare provision, mobile phone application has been used to request for medical intervention and monitor user's health condition. This mobile application helps to improve quality of health care service and quality of patient's life [4]. In the Philippines, victim and witness of the incident i.e. crime are able to report this case and request assistance from a nearest local officer using a mobile phone application. This mobile application connects to the website and server where relevant officers i.e. police and hospital staff will be notified and able respond to the reporter more efficiently [5]. In Bangladesh, a very dense population and mobile phone user country, there is an application performs 911- like services [6]. This application is an Android application available on Google Play Store. People can report various types of incident to the officer using this application. All requests are forwarded to the nearest emergency officer. This application will guide those officers to dispatch their services through interactive map accessing to reporters' location under Location Base Service (LBS) framework.

2 Methodology

2.1 Google Map Platform

This work applied Maps SDK for Android from Google. Mobile application developer is enabled to create various types of map on Android application based on Google Maps data. Google Maps servers handle the access of each application via the Google Map API key. Moreover, Google map servers also handle all other transactions automatically e.g. map data download, map display, and map gesture response. Google Map API allows developer to add map markers, map overlay, and polygonal objects on the Android application efficiently. Google Map API v.2 has been used in this project. However, the latest version of the API key is v.3 beta version which is not stable and available to normal developers to deploy it. With Google Map API v.2, developer is capable of changing map area view dynamically. When the researcher of this project compared strength and weakness of Google Map Platform with other map service provider i.e. Open Street Map. This map data provider offers online and offline service for map data. This provider also offers modular tile system and overlay map for mobile application. Developers can plot map marker and draw shapes for several objects displayed on the map. However, after performing thorough study and comparison, it is found that Google Map Platform is more versatile and suitable for this project than Open Street Map.

2.2 Firebase Firestore

Firebase service is Server-less service, meaning that developers do not need to create back-end system for user. However, developer just only prepare relevant SDK of each

platform in order to access to Firestore service on cloud and Firestore will handle all services. Firestore is NoSQL architectural structure. Therefore, there is no table or record structure similar to database. However, all data is stored in a format of document bound with its value. Each document is organized in to collection. Developer is able to create query to access to each data document in order to organize it. Cloud Firestore provides various types data e.g. string and integer. Developers can create sub-collection of data similar to the hierarchy for handling with complicated data structure. Additionally, Firestore also provides some other interesting features e.g. sorting, filtering, limits, and paginate to enhance developer's ability to manipulate data multi dimensionally.

2.3 Android Studio

This work deployed Google Map API key in the manifest file of Android studio in order to access to Google services. Java is a main language to code the program. Classes and fragments have been implemented in this project with real-time listeners and call back activities. This work also applied a framework of Location Base Service (LBS) to deliver geolocation data to all participants e.g. user and officer. Chopvitayakun has applied LBS in his work, Android mobile application to deliver information of places at Suan Sunandha Rajabhat University for visitors. This work offers on site map of the main campus and navigation feature to accompany visitor to a building or a place that the visitor is interested [7].

3 Result

Users have to register some important information for the first time use i.e. email address, names, citizen id number, and cell phone number. Once user finishes registering, user is able to sign in to the application and this application will remember all the credentials. Users do not need to sign in all the times. If user already has registered and forgot the password, user can retrieve this information through forgot password link as shown in Fig. 1. If user does not want to register, there will be Google account sign in button available for single tap sign in.

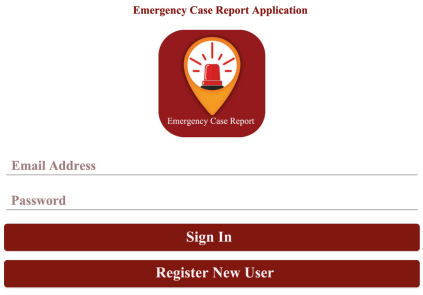

Fig. 1. Main screen for user

In case of emergency, user is just needed to specify case topic by selecting a topic listed in the drop down list box as shown in Fig. 2. Then, user is able to provide more details in the text box as incident context or additional information for officer. Current date and time will be stamped automatically by the application. However, user is able to modify date and time manually due to some constraints e.g. report a case back to its origin time 30 min to 1 h prior.

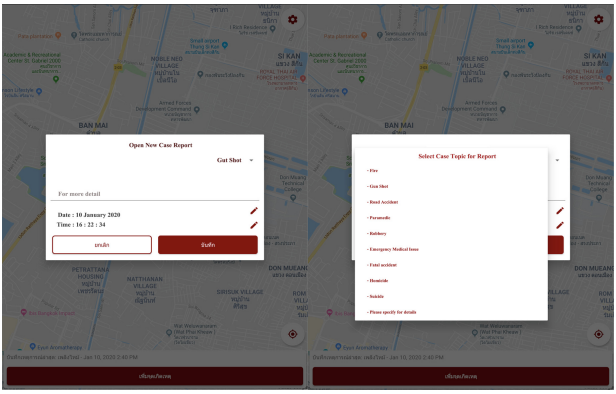

Fig. 2. Dialog box for user to make a case report

Once user fills out all the required details from the previous screen. There will be an alert dialog box notify user for all information provided by user as shown in Fig. 3. Geolocation of user, latitude and longitude will be shown on screen as well. This Geographical information is vital to the users. It can be used by other application e.g. Google map or other map applications.

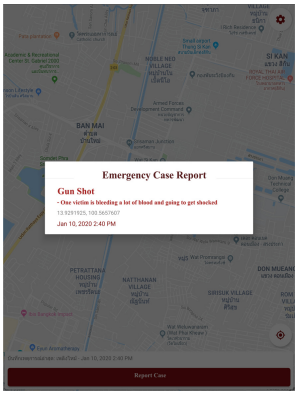

Fig. 3. Alert dialog previews case report detail provided by user

Application administrator must sign in with administrative account to access to the main menu. Administrator will be notified when there is a user fills in or report an emergency case to the system. Moreover, administrator is able to track that emergency case in-depth e.g. location and navigation. All reported cases will be shown on the map with different types of marker to indicate each case cause or type as shown in Fig. 4.

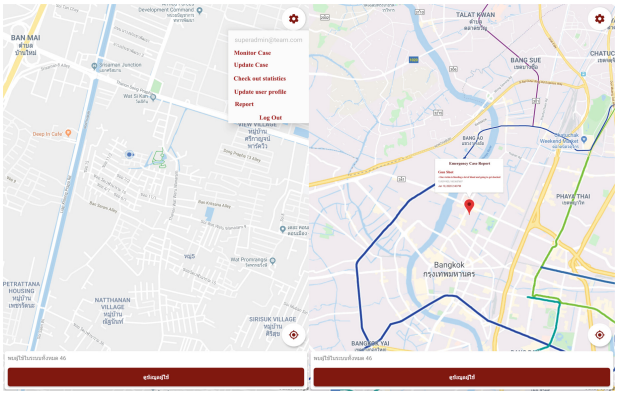

Fig. 4. Main menu for administrator

Administrator is able to see the over view of all incidents or cases. This application will list all cases reported by users pinpointed with different types of marker on the map as shown in Fig. 5. Administrator is able to tap or click on each marker to pop up an alert dialog box. This alert dialog box will provide all relevant information e.g. user's names, date and time of incident. After the administrator is notified with alert dialog box for a new case reported. The administrator can press and hold a long tab on that dialog box and open this reported location on Google Map Application to let this application navigate the dispatch team through real time traffic.

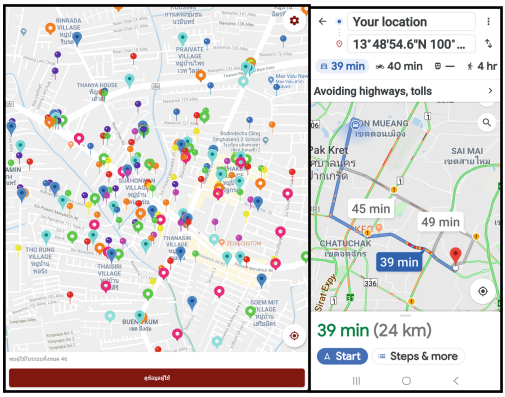

Fig. 5. Reported cases with map markers provided by users and road traffic navigation

4 Conclusion

Emergency Case Report is a user-friendly mobile application to both reporter and administrator. For user, it requires only minimum effort for user to provide required information. There will be automatic completion feature for some information assisted by the application i.e. location, IP address, date and time. However, user is able to modify this information manually in case of more precision needed. For authorized officer as administrator, there will be system notification shown on the screen promptly when there is case reported by user. Administrator can look up for more detail i.e. data of latitude and longitude or marker pinpointed on the map. Then, officer will be navigated through Google Map Application to approach the incident location. Once, the incident reported by user is done by officer. Administrator can remove the map marker from the incident map but its original data is still stored on the cloud safely. This application is a prototype waiting for software evaluation process and feedback for modification. Once all processes are done. It is ready for public access on Google Play Store.

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Mapping of Mangrove Change with Remote Sensing in Samut Songkhram Province, Thailand

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Abstract. The mangrove forest in Thailand provides food and many living organisms. Mangrove forests also provide important nursery habitat for many species of fishes. Therefore, knowledge on mangroves distribution and change is importance for effective management. Remote sensing and geographic information system has been widely used to characterize and monitor and studies on mangroves change. The main of research is monitoring mangrove forest land cover changes in Samut Songkhram Province from 2008 to 2018. This study used multi-temporal Landsat TM data and ancillary GIS data to quantify mangrove cover changes in the whole of Samut Songkhram. This research used supervised classification technique and NDVI index. Land-use was classed 6 groups which were mangrove forest area, urban area, agricultural area, bare land area, fishery farm area and water area. The result found that overall accuracy by calculating Error matrix during 53 to 83%. The mangrove forest area is increasing between 2008 to 2011 and 2015–2017. In the other hand, mangrove forest areas are decreased between 2011–2015. Information of mangrove forest area change of this study is very useful to local government and urban planners for the betterment of future plans of sustainable development of mangrove forest.

Keywords: Remote sensing · Geographic information systems · Mangrove forest

1 Introduction

Mangrove forest is an ecosystem that is unique and has high biodiversity. Mangrove forest is a very important component of the coast. It is an enormous valuable resource both economically and environmentally. Mangrove forest is a subsistence source of population along the coast, which relies on small-scale fishing and cultivation, raising aquatic animals along the coast. In addition, the mangrove forest is an important role in the protecting coastal areas, reducing the intensity of waves and wind storms, not harming the ecosystems, and helping to prevent soil erosion on the coastal areas from the erosion. It is a place to trap sediment, sewage, and various pollutants from land to

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sea, with the roots of trees in the mangrove forest that grow above the ground same as the natural materials are screened enclosure comes with the tides.

In addition, the mangrove forest helps the coastal land to grow into the sea, suitable for the cultivation of mangrove forest and coastal fishery as well [1]. The current balance of the ecosystems has been decreasing in sequence, due to the rapid economic and social growth, resulting in the expansion of the community, resulting in invading mangrove forest areas for used in housing and there is a need for use as a farming area for people in the area.

Currently, the remote sensing techniques are used in the resource exploration, and the application of geographic information systems in the mapping of land use, such as the study of forest area changes in the national forest in Krabi province [2]. Change analysis of plant distribution in South America from 1995 to 2005 [3] and including to the situation assessment or spaces analysis. Due to the remote sensing is a science and the art of acquiring the information relating with objects, space, and phenomena on the earth from preceptors without touching the target object. Based on the energy of electromagnetic waves as a medium for data acquisition, the basic concept of satellite image data analysis is to classify from reflections of different objects [4] Multi-temporal radar mosaics were manually interpreted for evidence of loss and gain in forest extent and its associated driver for distribution and drivers of global mangrove forest change, 1996–2010 [5].

This research interested the changes of the mangrove forest area in Samut Songkhram province, using Landsat satellite images and geographic information systems to store, collect, analyze, and display the data in a reference manner with geographic location in order to use the information efficiently. Mapping of mangrove change with remote sensing techniques, it will help to know the changes or the status of the area, is a tool to reduce the exploration time and obtain the useful information in the related work. The main objective is monitoring the mangrove forest area in 2008 to 2018 and investigating the accuracy of satellite data classification in tracking the changes of the mangrove forest area in Samut Songkram province.

2 Data and Method

Data and Collection: The data was divided into 2 groups, namely data collection from the field in the study area in Samut Songkhram province and data gathering from remote and Landsat satellites data.

Field data collection: The research team conducted a field survey to collect the coordinates of the sample area, various land use patterns, for a total of 6 groups, in order to use the sample data to classify land use with Satellite data.

The sample data (Training data) will consist of 6 groups are (1) agricultural areas, including various plantation areas, rice fields, field crops, horticulture, etc., (2) urban areas such as buildings, houses and important places (3) mangrove forest area, (4) aquaculture areas such as fish ponds, shrimp ponds, (5) water sources include rivers, canals and (6) salt evaporation pond.

The Land use classification in the study area, to obtain from field survey will be divided into 2 data sets. The first set will be used as training data to use as sample data in interpreting land use data from satellite imagery data using supervised classification technique, with the ENVI computer program for geographic information. The second set of data is used to check the accuracy and land classification data obtained from the interpretation of land use from satellite data.

Satellite Data: This research uses 9 imagery data Landsat 5 and Landsat 8, covering the entire area of Samut Songkhram province, download from the USGS (The united States Geological Survey) website 2008–2018, 9 images. The Landsat 5 satellite has a 30 m (TM) image detail, MSS (Multispectral Scanner), and TM (Thermatic Mapper) imaging systems. The Landsat 8 satellite has a pixel size of 30 × 30 m, with the operational land image (OLI) recording system. The satellite imagery data will be UTM coordinate system databases on WGS 84 evidence, details are shown in Table 1.

Table 1. The satellite data details

Satellite data	Date of data
Landsat 5 TM	5/03/2008, 24/03/2009, 23/02/2010, 25/01/2011
Landsat 8 OLI	6/03/2012, 5/02/2013, 11/03/2014, 14/03/2015, 13/02/2016

2.1 Methods

1. Image pre-processing by adjusting the atmospheric correction of every image. The recording of each image is different in time and the recording angle, resulting in the reflected light reflected in the image, having different values, and determining the two geometric corrections with using the reference coordinate system. The UTM WGS 84 zone 47N system modifies satellite imagery data from the digital numbers, as reflection reflectance, with the radiometric calibration.
2. Image classification, this step will identify land use by supervised classification, based on the maximum likelihood. Using the land use sampling data obtained from the survey, to use as a sampling ground of the data with looking at the reflection value of each pixel of the sample area, it can used to classify in other image points that appear in all images, for interpretation of land use in all image points of satellite.
3. Accuracy assessment checks the accuracy of the interpretation results of land use each year. Creating a random survey of land use from the interpretation of satellite image of each type, 30 points, a total of 180 points, comparing the results with actual land use conditions, field survey and satellite images highly detailed, and validated with overall accuracy, and Kappa Coefficient.
4. Represent land use map and mangrove forest area changes map with GIS technics

3 Results

The land classifications results divided into 6 groups that were mangrove forest areas, agricultural areas, salt fields, shrimp farms, rivers, and urban areas, and after that the only mangrove forest areas was selected and represent in Mangrove mapping. The result of the mangrove forest area during 2008 to 2018, that found year 2008 has the largest mangrove forest area, 23% of the total area, followed by the year 2011, 18% of the total area.

The results of the mangrove area classification from Landsat 5 from 2008–2011 (Fig. 1) and Landsat 8 from 2014–2018, were shown as a mangrove area map in each year (Fig. 2).

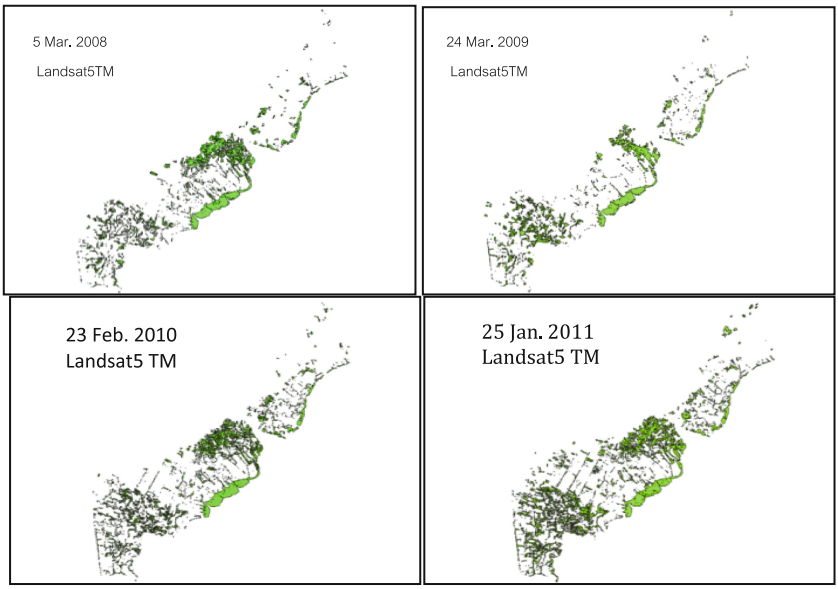

Fig. 1. The mangrove area classification from Landsat 5 satellite data from 2008–2011

The results of mangrove forest areas change, which has increased by 33.23%. in 2009 to 2010 The year 2010 to 2011, the areas of the mangrove forest has increased by 31.51%. The mangrove forest area are the most decreased in 2014–2015 and the forest area has decreased by 30.77% of the total area.

Fig. 2. The mangrove area classification from Landsat 8 satellite data from 2014–2018

3.1 The Accuracy Assessments

An error matrix was created for accuracy assessments of Land use from Landsat5 and Landsat8. The result of accuracy shown in Table 2.

Table 2. The accuracy of land use data of each group

Year	2008	2009	2010	2011	2012	2013	2014	2015	2016
Mangrove forest area	19.02	17.17	22.08	30.09	24.93	17.25	21.27	25.67	21.54
% Accuracy	73.46	91.29	91	86.89	89.50	76.97	93.13	97.6	89.74

Overall accuracy is a common index to measure reliability of classification. Overall classification accuracy was computed as the total number of correctly classified pixels divided by the total number of sample points. This research found the average accuracy of land use that found the accuracy value all areas is 72.17% (overall accuracy). The accuracy of land use data of each group area as shown in Table 2. The highest accurate percentage was Landsat on 2014 and the lowest accurate percentage was Landsat on 2008.

4 Conclusion and Discussion

The mangrove forest area has changed due to changes in land use, surveying or studying mangrove forest areas, are difficult to access. Therefore, the application of surveying technology to monitor changes in the mangrove forest area an important objective to study the changes in the mangrove forest area. The studying of Land use in Samut Songkhram province in 2008–2018 through Landsat 5 TM and Landsat 8 OTL satellite imagery with supervised classification technics that found the results showed the mangrove forest area has increased from 2008–2011, and started to decline in 2011–2015, and increased again during the year 2015–2017, and the area is reduced in the year 2018. The year that has the least land area is the year 2552, the area of mangrove forest area 17,173,800 m^2, and the year which has the largest area is year 2011, the area size is 30,091,500 m^2. The decreasing forest area may be due to the expansion of agriculture, especially the use of land for salt farming with an average of 34.71%. Due to the environment and location of the province facilitating salt farming, may result in encroachment on mangrove forest for more salt fields. Consistent with the research at Khao Phanom Bencha National Forest Reserve and Khao Phanom Bencha National Park in Krabi Province, there is a decrease in the rainforest area due to the population area, there has been encroachment of forest areas to change to agricultural areas such as rubber oil palm plantations [2].

There are similar changes in many other countries that have studied the decline in forest land size It has been changed to agricultural areas, such as education in Zimbabwe [5], Australia [6] and the Bordongo forest reserve in Uganda [7] The study results are in line with forest areas in the Yom River basin that have reduced the size of forest areas, most of which have changed to agricultural and urban areas [8] The results of the comparison study of changes in the mangrove forest area 2008–2018, the mangrove forest has increased to 13.27%, and checking the accuracy of the classification of satellite data, the coefficient kappa is in the range 0.5399–0.8359, because some parts of the image is cloudy and the shadow of the clouds covered.

The monitoring of changes in mangrove forest areas with remote survey, can be used to track, monitor the size of the mangrove forest quickly, save money and reduce the use of labor and budgets for surveying the area.

4.1 Recommendation

In this study, satellite images can be downloaded for free, therefore the image resolution is low and the clouds and shadows are partially covered by clouds, so the results of the classification of land use may be inaccurate.

Therefore, in order to increase the efficiency of mangrove forest classification, it may be possible to select satellite data with high resolution, will help to be more accurate classification and can classify land use more thoroughly, such as images from SPOT satellites. PLA system has details of 10 m., can study the city, village-level transportation routes, color MLA system, details 20 m. Study of forest encroachment in a small area and a small water source etc.

However, High resolution photos will also result in higher data prices as well. In addition, the data obtained can be combined with models for studying and forecasting mangrove forest areas, in order to apply the results of the study to the conservation and preservation of the forest beyond the future.

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Analysis of the Work System in an Object of the New Media and the Effects Generated in the Processes of Interaction with a User

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Abstract. It has been detected through dynamic networks that the interaction processes in a YouTube work system with audible sensory orientation generates Focal Attention Processes in less time and a decrease in the exploratory activity in the object, compared to the processes of Interaction performed without audible guidance. Which affects the perception of the aesthetic - formal elements in a user. The studies show, that the focal attention directed in a linear architecture work system, is not the most appropriate activity to generate detailed analyzes of the aesthetic - formal elements in artistic and design learning environments. Which requires detailed exploratory activities. Therefore, the intention of these studies is promote reflections on the appropriate use of technological tools and objects of the new media based on the effects and processes of interaction generated in a user.

Keywords: Human interaction processes · New media · Focal Attention Processes · Artistic and design environments · YouTube · Normal-vision user

1 Introduction

People execute different typologies of interaction through the work systems of the new media to obtain specific information, in which varied processes of human interaction take part. In this sense, the new media [1] delegate the greater hierarchy to the visual sense and a lesser extent to the combination with other senses.

In art and design educational environments, the new media are used for transfer information [2] to users. However, their qualities and the effects generated in a user are not analyzed; Generating an undifferentiated use of the new media in various environments without considering its effects on the user.

One of the most common objects of the new media in an environment of art and design learning in Mexico is the YouTube object. Through this object a user performs systemic interaction processes to obtain specific information in a given time. These processes tend to vary if the hierarchy of the user's sensory mechanisms are modified,

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and this affects the attentional processes [3]. Which is relevant in learning environments of art and design where the exploratory activity in the aesthetic - formal elements of an object, contributes in the construction of the user's mental models. Therefore, for these studies a comparative analysis of data was performed in which they are perceived how attentional processes are affected in relation to sensory mechanisms and how this affects the origin of the interceptive responses [4].

2 Process Description

The studies were developed from observation of the interaction process carried out by a normal - vision user (Nv) with the YouTube object work system. For this, dynamic networks were used for representation of case 1. In which, the relationship between the sensory mechanisms and the responses given by the user during the process of interaction with the work system[1] of the YouTube object[2] with audible orientation, was showed. And the representation of case 2. In which, the relationship between sensory mechanisms and responses given by the user during the interaction with the YouTube object work system without audible guidance, was showed. Likewise, each case was analyzed in two stages. The first one showed the relationship between sensory mechanisms and user responses during the process of interaction with the YouTube object through an adjacency matrix. The second one showed the relationship between the sensory mechanisms and the user's responses in the process of interaction with the YouTube object through a dynamic network.

2.1 Methodology

The methodology used for these studies was Learning Analytics with comparative analysis of data obtained with the design of adjacency matrices and use of dynamic networks for the visualization of information. For these studies the interaction processes performed by the user from the YouTube object, the activation of sensory mechanisms and the responses given during the process, were considered in the construction of the networks. The use of this methodology was applied in both cases, with audible guidance and without audible guidance. The process was applied to a Normal - vision user (Nv) who executed the following tasks: 1. Locate the X YouTube object in the work system of a cell phone. 2. Enter to the X YouTube object. 3. Receive the information of the X YouTube object with audio for five minutes. 4. Change of YouTube object to Z in the same work system. 5. Receive information on the Z YouTube object without audio for five minutes. The following tables and figures describe the analysis process (Tables 1, 2 and 3):

[1] The work system is the physical component of the Work System in which human work has an effect [5].

[2] Concerning to the Dynamic media: media in which the presentation to the user changes according to time Example: These include video, music, animation [2].

Table 1. General nomenclature

Sign	Description	Sign	Description	Sign	Description
Iv	Visual interaction	Is	Sound interaction	Pd	Digital pressure
Prop	Proprioception	Intero	Interoception	S	Symbol
Imf	Fine motor interaction	Em	Emotion	Elem	Elements
Img	Gross motor interaction	PAF	Focal Attention Process	PAG	General Attention Process

Table 2. Process adjacency matrix with audible sensory orientation. Elaboration Olmos & Gil 2019.

	Is	S	PAF	Mlp	Iv	Imf	Prop	Elem	PAG	Intero	EA	Mcp	Pd	Img
Is	0	1	1	1	0	0	1	0	0	0	0	0	0	0
S	1	0	1	1	0	0	0	0	0	0	0	0	0	0
PAF	1	1	0	1	0	0	0	0	0	0	0	0	0	0
Mlp	1	1	1	0	0	0	0	0	0	0	0	0	0	0
Iv	1	1	1	0	0	1	1	0	0	0	0	0	0	0
Imf	1	1	1	0	1	0	1	0	0	0	0	0	0	0
Prop	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Elem	0	0	0	0	1	1	1	0	1	0	1	1	0	0
PAG	0	1	0	1	1	0	0	0	0	1	0	0	0	0
Intero	0	1	1	1	1	1	1	0	0	0	0	0	0	0
EA	1	0	0	0	0	0	0	1	0	0	0	1	0	0
Mcp	1	1	0	0	0	0	0	0	1	0	0	0	0	0
Pd	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Img	0	0	0	0	0	0	0	0	0	0	0	0	0	0

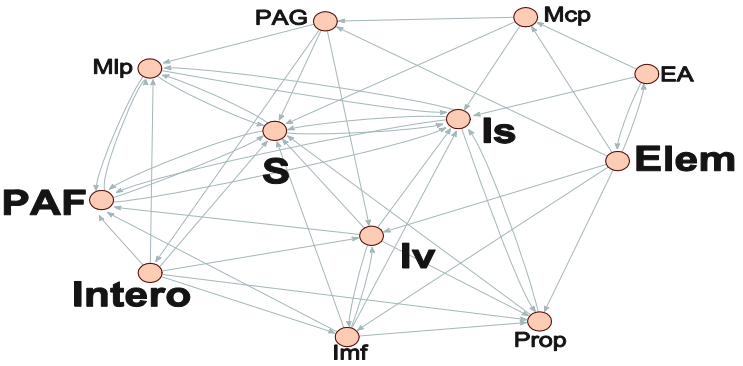

Fig. 1. Dynamic network that shows the relationship and distance of the sensory mechanisms with audible orientation in the YouTube object work system. Elaboration L. Olmos & J. Gil 2019.

Table 3. Node grades.

Sign	Grade	Sign	Grade	Sign	Grade	Sign	Grade
Iv	9	Is	12	PAF	9	Elem	7
Intero	7	S	12				

Figure 1 shows a greater correlation between Focal Attention Processes (PAF) with Audible Symbols (S) and a lower correlation of Focal Attention Processes (PAF) with Visual Elements (Elem). Likewise, a distance 1 is perceived between the Focal Attention Processes (PAF) and the Symbols (S), which indicates a close relationship in relation to audible orientation; and a distance 2 between Focal Attention Processes (PAF) and Visual Elements (Elem), which indicates a lower relationship with the aesthetic - formal elements of the YouTube object. Interoceptive responses (Intero), were linked to the Visual Interaction Processes (Iv) and Symbols (S), the latter audible (Tables 4 and 5).

Table 4. Process adjacency matrix without audible sensory orientation. Elaboration Olmos & Gil 2019.

	Iv	Imf	Prop	EA	Elem	Mcp	PAG	S	Intero	PAF	Mlp	Is	Pd	Img
Iv	0	1	1	1	1	1	0	0	0	0	0	0	0	0
Imf	1	0	1	0	1	0	0	0	0	0	0	0	0	0
Prop	1	1	0	1	1	0	0	0	0	0	0	0	0	0
EA	1	1	1	0	1	1	0	0	0	0	0	0	0	0
Elem	1	1	1	1	0	1	0	0	0	0	0	0	0	0
Mcp	0	1	0	0	1	0	0	0	0	0	0	0	0	0
PAG	1	1	1	0	0	0	0	1	0	0	0	0	0	0
S	1	1	1	0	0	0	1	0	0	0	1	0	0	0
Intero	1	0	0	0	0	0	0	1	0	1	1	0	0	0
PAF	1	1	1	0	0	0	0	1	1	0	1	0	0	0
Mlp	1	0	0	0	0	0	0	1	1	1	0	0	0	0
Is	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pd	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Img	0	0	0	0	0	0	0	0	0	0	0	0	0	0

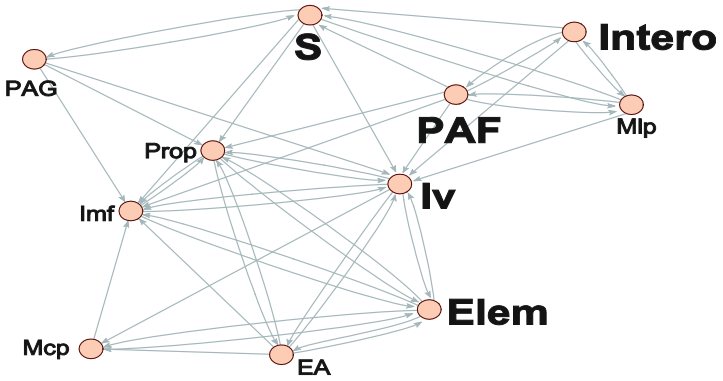

Fig. 2. Dynamic network that shows the relationship and distance of the sensory mechanisms without audible orientation with the YouTube object work system. Elaboration L. Olmos & J. Gil 2019.

Table 5. Node grades.

Sign	Grade	Sign	Grade	Sign	Grade	Sign	Grade	Sign	Grade
Iv	13	PAF	8	S	9	Elem	10	Intero	6

Figure 2 shows a greater correlation between the Focal Attention Processes (PAF) with the Visual Interaction (Iv) directly related to the Elements (Elem) of the YouTube object that are from a visual typology. Likewise, a distance 1 is perceived between Focal Attention Processes (PAF), Symbols (S), Visual interaction (Iv), and Interoception (Intero). A triadic relationship between Focal Attention Processes (PAF), Visual interaction (Iv) and Interoception (Intero) is perceived. Which is related to the Interoceptive responses (Intero) and the Focal Attention in the visual elements. However, a distance 2 is perceived in relation to the Focal Attention Processes (PAF) with the Elements (Elem) which are from a visual typology.

3 Results

Based on the comparative data analysis the following results were given: In the first case, it is observed that the user centers the Focal Attention Processes on the audible Symbols (S). Based on this, there is a probability that the type of focal attention used by the user is necessary for the understanding of the audible symbols. Therefore, the attention delegated to the visual elements and the aesthetic-formal elements is less in relation to the attention delegated to the audible Symbols (S). Furthermore, in this case it is observed that the Interoceptive responses (Intero) of the user can be given by the audible Symbols (S) and by the Visual Interaction processes (Iv). In this case the audible Symbols (S) are the most in probability to generate the Interoceptive responses. However, the results show that the Visual Elements (Elem) have a very strong

closeness in relation to the Focal Attention Processes (PAF) during the process, which generates a stimulus capable of modify the object of the attentional processes.

In the second case, a considerable change is perceived in relation to the Focal Attention Process (PAF) whose origin is determined by the processes of Visual Interaction (Iv) and directly related to the Visual Elements (Elem) of the YouTube object. Likewise, the Interoceptive responses (Intero) were oriented to the Visual Symbols (S) contained in the YouTube object. In comparison to case 1, a decrease in Focal Attention Processes (PAF) and an increase in General Attention Processes (PAG), are perceived. This typology of Attention allows the user to have a greater field in the perception of different stimuli.

4 Conclusions

These studies showed that the sound interaction is a factor that activated almost immediately the Focal Attention Processes in the user. Which affected the processes of visual interaction in the following relationship: the greater the Focal Attention with audible Symbols, the lower the Focal Attention to the visual symbols. It also affected the orientation of the user's Interoceptive responses in the following relationship: the greater Focal Attention with the audible symbols, the greater the probability of generating Interoceptive responses from audible symbols and the lower probability of generating Interoceptive responses from visual symbols.

However, studies show that the Visual Interaction, although in a lesser degree than the Sound Interaction, behaved as a latent stimulus in the user, capable of generate a breaking point in the Focal Attention Processes delegated to the audible symbols. This was observed when there is an Interoceptive response of visual genesis. Likewise, it was observed that the attentional processes are first oriented to the Visual Elements, except when there are emotional Interoceptive responses in the user with symbolic genesis.

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Development of Web Application in English Subject

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Abstract. An objective of this research paper is to develop of web application in English subject, and to study the students' satisfaction in using the created web application. The sample of this research was 87 students who studies in Grade 7 at the Bangpakok Wittayakom School, Thailand from purposive sampling method. The research tools included the web application in English subject, and the students' satisfaction form on the created media. As a result, the average satisfaction score is 4.53 and standard deviation is 0.57 in a good rate.

Keywords: Smartphone · Web application · English

1 Introduction

In the age where technology involves many aspects of our daily life, knowledge and information spread quickly and prevalently. The advancement of related technologies plays significant roles in the application with learning and teaching activities. As a result, many technologies are applied to the learning and teaching activities, in the form of various learning media, such as videos, learning material, etc. Using the web application as an instrument for knowledge management is another educational innovation, which affectively allows students to access the lessons anywhere and anytime, is the answer to the current demands for easy access.

The English language is an important language used and accepted internationally as a common language for communication, as a tool that provides access to various sources of technology and knowledge [1]. The English language serves as a medium for spreading the information and knowledge in various fields [2] and as an important tool for the pursuing many careers, and understanding the culture, tradition, and vision of other nations [3].

Therefore, it is extremely important for promoting Thai people to learn and to improve their English language-related skills. It is recommended that the English language should be integrated into the learning and teaching activities; and that technologies should be implemented for the promotion of the English language learning, through the production of various learning materials. On the other hand, the prevalence of mobile applications allows users to access and use various applications at any time and any place. One important aspect of the English language learning is the learning of

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vocabulary. The larger a vocabulary one learns allows one to understand and communicate with other people easier. Vocabulary is, therefore, a very important component for learning any language; and is a starting point for the development of the four language skills: listening, speaking, reading, and writing. Russel [4] remarked the importance of vocabulary as the fundamental principle for learning any and all subjects. One may only able to read, speak, write, or express one's opinions fluently after one learns and understands the vocabulary before one may learn other subjects. A stereotype of student's attitude in English refers that it is very difficult to study English [5]. Many of them are not interested in this subject also don't understand how to learn.

Therefore, the researcher recognizes the necessity to improve the student's efficiency in English vocabulary learning, by using a web application for teaching the English vocabulary to the 7th-grade – junior high school students, which will be further beneficial for the development of the 4 core language skills, namely, listening, speaking, reading, and writing.

2 Related Works

Development of the web application for education as the web application can be provided through the wireless technology and the internet, hence, allowing students to access the learning materials from any place, at any time, with any devices. Research studies on the subject of the web application are, as follows. [6] studied the subject of the web knowledge management application, using smartphones, for bachelor degree students. The evaluation result revealed that the web knowledge management application using smartphones, in terms of the media and the content, performed quite well. The aspect with the highest score was 'the content is easy to understand.' This was because teachers want to promote students to learn on their own, using the web-based knowledge management application.

Moreover, there are many research studies on the subject of developing the web application for other purposes. For example, [7] developed a web application for the health examination system that allows the data to be stored systemically. The system solves the problem of data loss. It is easy to use. It can process the data quickly and greatly helps reduce the waste of resources. [8] developed a web application for the management of the construction project of the Provincial Waterworks Authority. The developed system facilitates PWA to store, search, and access the data easily and quickly; and it is practical in the real situation.

3 Methodology

3.1 Web Application

The web application is a type of application that is accessible and usable through the internet browser. Therefore, the web application is suitable for operations that require real-time data. The advantages of the web application are, including, the availability of data through the online system that allows service providers to interact with users in a

real-time manner, and thus further improving users' satisfaction with the application. A web application can be used easily, without the need to install the client program. Therefore, there is no need to update the client program. The web application is also usable with a low-speed internet connection. Therefore, users may access applications from anywhere in the world. Examples of suitable online systems to be implemented as web applications are, including, the booking system, the human resource management system, the marketing management and planning system, etc [9].

3.2 Bootstrap

Bootstrap is the Front-end Framework that consists of CSS, HTML, and JavaScript. Bootstrap allows developers to create the application's user interface easily, quickly, and beautifully. Bootstrap reduces the time required for designing the interface's layout or other elements. All the forms can be managed using Bootstrap. Bootstrap also contains CSS components and JavaScript plugins that work in conjunction with jQuery and can be used for various applications. And most importantly, Bootstrap presents the result in a responsive manner, that is, presents the result under the suitable environment of the devices used for displaying the result, such as PC desktops, tablets, smartphones, or other devices. Bootstrap allows web designing and programming to produce the result that can be used by all devices.

3.3 PHP (PHP Hypertext Preprocessor)

PHP is an open source programming language. It is a type of Scripting Language. All the commands are stored in a file called Script. In order to use the commands, users will require a specific interpreter for the language. Examples of Script Language are, including, JavaScript, Perl, etc. PHP is different from other Scripting Languages as it was developed specifically for the creation of an HTML document, whereas PHP allows the document to be updated or modified automatically. Therefore, PHP is a type of Service-Side language, or the HTML-Embedded Scripting Language. PHP is an important tool that allows users to create Dynamic HTML documents efficiently. PHP also provides a wider range of available tools for users.

3.4 The Instruments Used for the Application Development

3.4.1 A web application for teaching English vocabulary to 7th-grade students.

3.4.2 A questionnaire for evaluating users' satisfaction for the web application for teaching in English subject.

3.5 Designing and Developing the Web Application in English Subject

The development of the web application for teaching English vocabulary can be divided into 4 main phases, as follows.

3.5.1 Studying and gathering related information on the development of the web application in English subject.

3.5.2 Analyzing and designing the web application for teaching the English language; this phase consists of 2 parts, namely, the vocabulary module, which is further divided into 2 formats, as per the usage and the category. The second part is the game module, whereas there are 4 games: Word Guessing, Crossword Puzzle, Hangman, and the Toasty.

3.5.3 Developing and testing the web application for teaching the English language, using the samples of 87 the 7th-grade students.

3.5.4 Evaluating the result of using the web application for teaching the English language, using the questionnaire for evaluating users' satisfaction with the web application in English subject.

4 Result

4.1 Result of the Development of the Web Application in English Subject

The author developed a web application for teaching English vocabulary to 7th-grade students, as follows (Fig. 1).

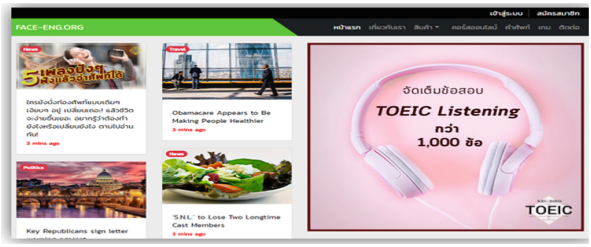

Fig. 1. Homepage of the web application

After accessing the game menu, users will find that the application presents 4 games as Word Guessing, Crossword Puzzle, Hangman, and The Toasty, as depicted in Fig. 2.

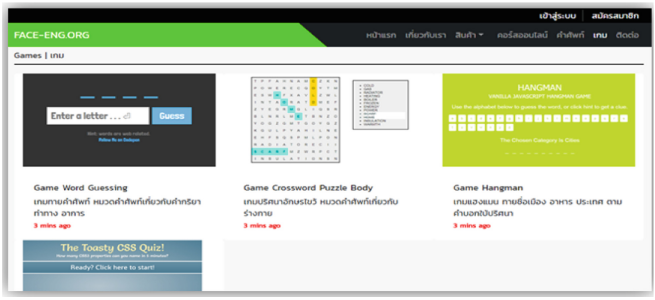

Fig. 2. The 4 games presented in the application

4.2 Evaluation Result of Users' Satisfaction with the Web Application in English Subject

For the evaluation result of users' satisfaction with the application, users were 87 7th-grade students and the author evaluated their satisfaction in 4 aspects, namely, (1) the functionality, (2) the content, (3) the system design, and (4) the system's processing capability. The result is depicted in Table 1.

Table 1. Evaluation result of users' satisfaction with the web application in English Subject

Evaluated aspect	Opinion		
	$\bar{x}$	S.D.	Meaning
1. Functionality	4.50	0.62	The highest
2. The content	4.53	0.59	The highest
3. The system design	4.52	0.56	The highest
4. The system's processing capability	4.57	0.52	The highest
Total average score	4.53	0.57	The highest

According to Table 1, the evaluation result of users' satisfaction with the developed application in 4 aspects revealed that the total average score was 4.53 with the standard deviation of 0.57. This means users had the highest level of satisfaction with the application. For the detail evaluation result of each aspect of the application, the result revealed that users were satisfied with the system's processing capability, with the score of 4.57 and the standard deviation of 0.52. This was followed by users' satisfaction with the content, with the average score of 4.53 and the standard deviation of 0.59; the system design, with the average score of 4.52 and the standard deviation of 0.56; and the functionality, with the average score of 4.50 and the standard deviation of 0.62.

5 Conclusion

The researcher aimed to develop a web application in English subject, to provide a source for learning English vocabulary that is sorted into various categories, and to create a learning media that students can use for learning of the English language, using various media, including videos and sentences, whereas students may access the learning contents from any place and at any time, as per their demands. The samples used for this research were the 7th-grade students of Bangpakok Wittayakom School.

For the evaluation result of users' satisfaction with the web application in English subject, the researcher used a questionnaire to evaluate the satisfaction of 87 samples in 4 aspects. The result revealed that students were highly satisfied with the system's processing capability, with the score of 4.57 and the standard deviation of 0.52. This was followed by users' satisfaction with the content, with the average score of 4.53 and the standard deviation of 0.59; the system design, with the average score of 4.52 and

the standard deviation of 0.56; and the functionality, with the average score of 4.50 and the standard deviation of 0.62. The result showed that students' satisfaction with the application was at the highest level.

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Human–Computer Interaction

A Distributed Multimodal Multi-user Virtual Environment for Visualization and Query of Complex Data

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Abstract. This paper describes an early prototype of a distributed multimodal multi-user virtual environment used for the visualization and query of complex data. The system supports different user interfaces for viewing coloured 3D objects of various sizes representing high-dimensional data to allow visual exploration and pattern detection in the data. Users can navigate and query the environment by using multimodal interaction techniques including speech and gesture recognition. The system serves as a testbed to compare the usability of various interaction techniques for visualization and query of complex data.

Keywords: Human-centred computing · Virtual reality · Visualization

1 Introduction

The current information explosion and the Internet of Things (IoT) motivated by the unprecedented advances in communication, sensor and computing technologies are not only generating huge masses of data at increasing rates, but very importantly; are producing complex heterogeneous information. This heterogeneity refers to collections of variables of scalar, vector or more complex structures with different types of values: numeric, non-numeric, images, signals, videos, etc. These variables describe objects, problems, situations or processes from a broad variety of domains and come with imprecision and incompleteness of different degrees. This variation further contributes to heterogeneity.

It is widely acknowledged that we are flooded with data, but starved for knowledge. Making sense of information, and importantly, gaining insight, is imperative to pave the way to new discoveries and to realize coming investments in data gathering and processing infrastructure. The coming growth of information in size and complexity will only increase our need for user-friendly tools to allow us to explore information, to reveal its structure, and to understand its embedded relationships. Traditional techniques are no longer sufficient for these purposes, so new, innovative solutions are required. In particular, approaches that leverage the massive parallel processing capabilities of the human brain and senses are extremely appealing. Such approaches would be more intuitive, require less specialized knowledge and could reach broader

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audiences. Not surprisingly, understanding masses of heterogeneous information is a continuously growing need in many domains, from medicine, health and life sciences to astronomy, economics, many industries, finance, the military and the environment.

While artificial intelligence-based data analytics techniques represent a major advance towards the goal of making new discoveries and the development of prediction and problem solving systems through intensive computing, human understanding of the information is often required.

The human brain, coupled with the senses represent a formidable data acquisition and processing system involving very high throughput information input and massive parallel (low power) information processing capabilities. The problem is that the way in which the information is acquired and warehoused in databases is not in a format amenable to human processing, which is essentially based on perception of patterns (visual or otherwise) and not on numeric computing or formal logical deductive reasoning. It is known that humans perceive most of the information through vision, in large quantities and at very high input rates. The human brain is extremely well qualified for the fast understanding of complex visual patterns, and it still outperforms the computer, at least with ill-defined visual stimuli [1].

The role of visualization techniques in the knowledge discovery process is well known [2]. The amount of information contained in real-world datasets is big, as are the results obtained from data processing computer procedures, which may be large and complex, possibly involving underlying space or time dependencies.

Moreover, in many cases it is preferable and sometimes necessary to engage the expert in the data mining process through interactive visualizations [3–5]. This makes graphical representation directly appealing, particularly, the use of virtual reality approaches (mixed, augmented and virtual reality techniques will be referred to as VR techniques). Several reasons make VR a suitable paradigm: it is flexible (allows the choice of different representation models according to human perception preferences), it allows immersion (the user can navigate inside the data, interact with the objects, etc.), creates a living experience, and it is broad and deep (the user may see the whole world and/or concentrate on specific details). Moreover, the user needs no mathematical knowledge and only minimal computer skills.

The potential of virtual environments (VE) for visual data analysis has been recognized for a long time [6–8]. However, the design space of the user interface to interact with such environments is huge and little is known about the optimal way to design it [9, 10].

This paper describes a prototype system developed to allow several users to collectively join, navigate and query a virtual environment that represents high-dimensional data that has been reduced to virtual objects of various sizes and colours in 3D space. The purpose of this system is to exploit the power of the human visual system to explore, visualize and query complex databases for detecting patterns of interest in the represented data.

The system's architecture is based on the functional diagram shown in Fig. 1. An original database is translated into a collection of geometric constructs representing data records, logical relations and other database properties, used for assembling a mixed/augmented/virtual reality environment. The user interacts with the VR environment through a diversity of mechanisms that allow navigation and querying of

different kinds, formulated within the VR space. The results of the querying process are translated back to the VR space as augmented information and/or new geometries.

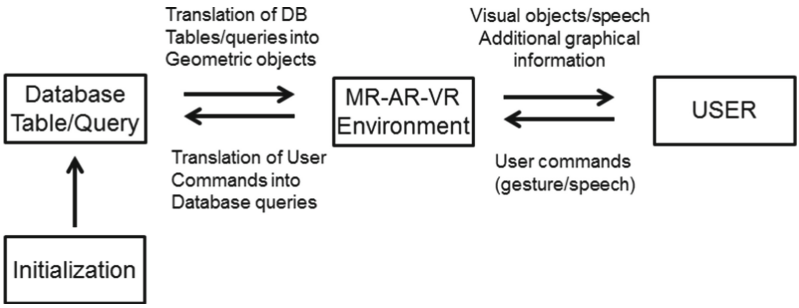

Fig. 1. General architecture of the virtual reality system

Typically, the process of querying the database requires specialized knowledge, which is beyond the average user who has data and wants to explore and understand the information contained within. Moreover, the results of database queries typically produce tabular information, which needs further processing. In the context of large amounts of data, it is extremely difficult for the user to get a sense of the structure of the data and it becomes difficult to explore and understand the information.

However, if the information is represented graphically, as in our VR system, the user's understanding arises effortlessly from perception, rather than requiring effortful computation or deductive reasoning. With this VR approach, the user is able to interact with the information using his senses (vision, speech, etc.), in an intuitive manner, pretty much in the same way in which humans interact with physical objects in the real world. This approach therefore enables the use of the powerful pattern recognition capabilities of the human brain in combination with his expert knowledge, which is seamlessly incorporated into the process.

To create a VR space representing the data it is necessary to transform the original database table containing the collection of objects, described in terms of heterogeneous, incomplete and imprecise properties. Typically, this is an abstract, high-dimensional space which must be transformed into a low-dimensional one (2D, 3D) amenable to human exploration. From a mathematical point of view, this problem has been extensively investigated and there are many linear and nonlinear procedures suitable for producing such mappings [11–16]. The basic idea is to focus on a certain property of the data and to design an appropriate algorithm that will preserve the chosen property as best as possible between the two spaces: the original high-dimensional one, and the target, low-dimensional space (Fig. 2). Properties that have been chosen for data representation have been the preservation of similarity/distance structures, the distribution of class information associated to the data objects, neighbourhood composition and many others. Due to the complexities involved, the algorithms are overwhelmingly nonlinear and the dimensionally reduction processes typically results in an information loss, which the algorithms attempt to minimize according to a multitude of strategies.

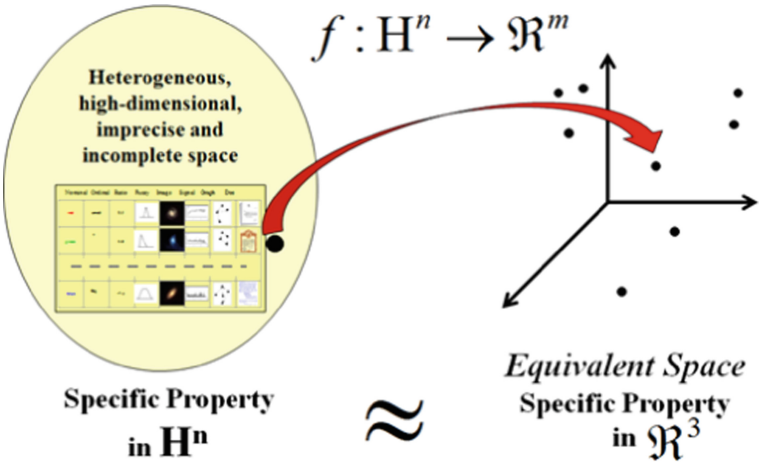

Fig. 2. Construction of a low-dimensional space preserving a chosen property of the data in the original n-dimensional space (Hn), to an m-dimensional one (Rm), where f is the mathematical transformation. The goal is to preserve the chosen property as much as possible in the target space. Data objects from Hn are mapped to objects in Rm space (black dots), so that their geometric distribution is compliant with the property whose preservation is required.

2 User-Centred Interactions

In this system, a common VE can be viewed by several users, each represented in the VE by an avatar that can be seen by the other users. Each user can navigate through the VE with his/her avatar. Navigation can be performed through speech (e.g. commands to translate and stop) and/or other interaction techniques. The query of objects representing different points of the database can be done through gesture.

3 System

The system is built using the Unity game engine and runs on a Windows computer equipped with an Oculus Rift S head-worn display (HWD) and a LeapMotion device.

The first step in generating a virtual environment is converting the desired dataset into a 3-dimensional representation that can be visualized by users. This is accomplished using an in-house tool labelled as DBVI in Fig. 3. Behind the scenes, Forge Networking Remastered is used to synchronize the VE clients who are connected.

Although Unity can easily handle a large number of game objects, synchronizing these objects via the network isn't straightforward. Datasets can produce anywhere from a hand full of objects to a million or more, so a custom addition to Forge was built to accomplish the synchronization.

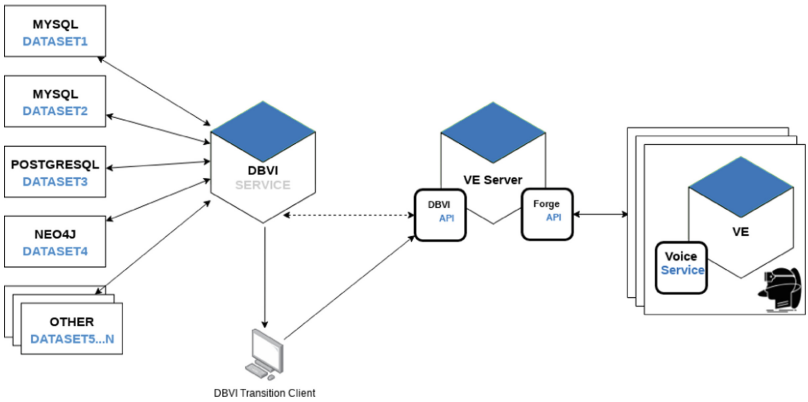

Fig. 3. Overall system architecture

A multiplatform client has been built that allows rapid transitions between datasets, in addition, the architecture is designed to allow live changes directly from within the VE to perform actions such as SQL queries, subset selection, or even manipulations that are persisted in the original dataset or elsewhere.

Voice-based interactions are built using Microsoft's Speech API and leverages the Speech Recognition Grammar Specification Version 1.0 (SRGS) and the Semantic Interpretation for Speech Recognition Version 1.0 (SISR) W3C recommendations.

4 Conclusion

Further system development and testing is needed to optimize the 3D user interaction techniques and database queries. In that context, explicit user performance data with various interaction techniques needs to be collected and analyzed to obtain objective conclusions regarding the best interaction techniques. In addition, we must clarify the benefits of having multiple concurrent users for the visualization and query of data.

5 Future Work

A series of system evaluation studies are planned to assess the usability of the various interaction mode that have been implemented in the system both for navigation inside the VE as well as for the query of the various objects present inside it. The results of those studies will help the designers to better select the UI component of such system, especially given the large space of possibilities.

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Individual Trace in Knowledge Space: A Novel Design Approach for Human-Systems Interaction

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Abstract. Data mining design is an approach through which system operational improvements in the search and retrieval of data activity can be augmented. This study explores optimisation processes, including data harvest, analytics and visualisation plus covers a wide range of efforts, including identifying the growing need of 'making-sense' of data which requires contextual understanding. In both cyberspace and physical world experiences the exploring of challenges and linkages between the cyber-physical knowledge spaces in data are emerging with excessive amounts of raw data. Possibilities to improve User-interface-design through better visualisation infographics in this study propose a novel mapping approach called 'Trace' in the Knowledge Space enabling design opportunities that help articulate unique human-system interaction, which provide potential in re-imagining and re-structuring uses of interaction and user-experience. These experienced through the design, use and context of languages enabling the building of new interactive apparatus, algorithms and dynamics in collective intelligence.

Keywords: Human-systems Interaction · Knowledge Space · Individual Trace · Second Order Cybernetics · User Interaction Design

1 Introduction

Operational improvements in the search and retrieval of data enabling greater breath of understanding how to utilise and augment human and machine productivities are central to developing cultures of efficiency. New software models refined through precision algorithmic Machine learning are leading optimisation and approaches for heightened human-machine hybridity, requiring greater capability in understanding data analytics to achieve better intelligence. We believe this approach can be further improved through increasing Artificial Intelligence capabilities in learning and enabling data predictions and re-structuring the relationships between machine and human interaction. Creativity and opportunity are embedded and await articulation through content from texts, imagery, networks of libraries and archives and the complex mass

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of data. The Individual Trace in the Knowledge Space approach proposed in this paper could help in this sense to augment insights understanding therefore to enhance human-system interactions.

Speech input in interface design drives embodied interaction enhancements in Systems design, with an added component to the previously more dominant visual graphic interfaces connecting and engaging users monitoring, analysing and visualising data. However, there is an emerging trend in 'always-on' connectivity available, such as in-ear systems, speech and the more haptic, gestural or optically driven technologies. This new expanded interface optionality utilising a broader range of sensory input mechanisms creates a more embodied user as co-bot partnership. Working in highly technologically advanced networks, design is evolving into a more progressive human-plus-machine hybridity [1].

Heightened integration of human interaction by emerging technologies has led to the design of cloud-based and web 4.0 applications. Integration incorporates a range of gestural and voice interaction thereby creating greater scope for engagement in and through user interface innovations such as application programming interfaces. The developments for improving human-system communication and interaction continue further developments in designing better design processes and greatly enhancing co-design methods to further support heightened user-experience, interaction capacity and productivity efficiencies.

In order to pivot the context of the individual's embodiment within the footprint or trace of emerging and adapting libraries, it is useful to revisit the interaction and meshwork of connections. In this paper, there are two inter-related sections:

Firstly, introduce the concept of Enhancement of Human-Systems-Interaction (HSI) through literature review in the fields of Hyper-linked search and retrieval, Second Order Cybernetics and Spatialised Cognition understood through a Constructionist approach.

Secondly, propose a novel method called 'Individual Trace in the Knowledge Space' (ITKS). ITKS is a research framework which aims to create a new approach in methodology to further understand the potential in efficiencies to sort, filter and re-structure data over-load by mapping data communication trajectories and interactive-relationships transforming raw data through analytics, modelling, simulation and optimization for enhanced User Interface design.

2 Enhancement of Human-Systems-Interaction (HSI)

Enhancements in human-systems design for interaction are understood through bespoke interactive coded language. The variety of which are represented from raw through to highly dedicated algorithms as building blocks in input data. These differing inputs of coded 'languages' are used to drive and augment access to the IoT as well as indigenous knowledge spaces like libraries, industry operations systems and bespoke digital archives. Jon Kleinberg's research from the perspective of HITS: Hyperlink-Induced Topic Search is known also as the Hubs and Authorities algorithm [2]. HITS algorithm is interesting in its application from Hyperlink-Induced linked search and retrieval being one of the key algorithmic influences for the success of Google's evolving search engine. Kleinberg's research on 'Authoritive Sources in a Hyperlinked

Environment' [2] presents ideas for making sense of how an emerging network of hyper-linked hubs can point at or 'join' authoritative sets of collective intelligence in Web-based archives. This approach contextualizes content in an agile network of Hubs that point to continually updating Authoritive knowledge sources.

To build on Kleinberg's ground-breaking studies Gary Flake's research from the context of trace within data search legacies focuses on Communities of similarity in search & retrieval data characteristics [3]. The 'Community of similarity' algorithm [4] that was developed being instrumental to the construction of the innovative 'browser' interface Flake named Pivot whilst leading the Live labs research studio at Microsoft [4]. The '*Community of similarity'* algorithm [3] built from a parallel mindset to that of Page-rank in open-source browsers like Google, Firefox and Opera amongst others, with search interaction being designed through adaptive filtration of data subsets in search and retrieval interaction creating a diverse search engine functionality. The idea underpinning Communities of similarity in hyperlinked pages/phrases or strings of data is a useful comparator of relationships to the 'HITS' Hyperlink-Induced Topic Search [2] that ranks use-case searches and therefore constructing an evolving taxonomy related to network content through both the context of text, image, dates and publication origins.

The Pivot browsing utility interfacing internet 'web' connectivity through visualisation geometry creating 'Collections' [4]. Collections being grids of grouped information presented through image matrices in context to data search streams in a unique adaptive browser experience in a live infographic. Through zooming into the dense visual patterns of data imagery, the user has access to dynamic interaction rather than a linear search and retrieval presentation for a browser search tool. This has the capacity to transform data in context to both glanceable infographics and schema structures mining the workflow into 'Communities of pages' in a recursive exploration of content [4].

Interaction in archives through recursive activities supporting communities of content and ranking in search hierarchies of data evolves the capacity of machine learning, augmenting AI in smarter algorithms to search browsers. This likewise informs the methods for designing improved efficiencies in digital interaction. To enable greater variety in interaction 'actors' and can be understood as an approach that provides insights for design automation and new discoveries for innovating learning. In other words, the increased knowledge from a broader approach to collaborative machine and human collective intelligence applied to observing, capturing, and adapting communities of data as well as fulfilling search and retrieval interaction objectives can achieve a greater organisational and productive goal set [7]. This interaction achieved through a navigational cycle steering designed interactive 'conversations' [5] being organised between the stakeholders involved in objectives and aims of industry. The interaction step-by-step method being compared to and named 'conversations'. The design and evaluation objectives fulfilling human interaction through setting goals via a circular nature of Systems-design [5]. Likewise designing understanding to improve the potential of 'wants' from what is presented and adapting this data in a First order approach via Search engine feedback. Second Order systems design adapts the user experience by observing and participating in the activity of search. this is likened to the helmsman of a ship, steering and adapting to weather conditions to navigate to a chosen destination [5]. 'Conversation theory' was developed by Gordon Pask originally with Paul Pangaro further developing this subject through research both

celebrating and curating Pask's work. However also building on Conversation theory applied to Second Order Cybernetics in a number of live projects that explore designing ethics in interaction and co-evolutionary design in organizations and society [5]. Pangaro's research and work exploring the design of interaction through mapping out focus aims within conversations enables resource needs to fulfil a process whereby interaction with actors is designed to facilitate knowledge that contributes to resolving transactions and fulfil set goals [5].

3 Individual Trace in the Knowledge Space (ITKS)

From 2015 Web3.0 functionality has grown from an interactive and social network approach that facilitates collaborative search, retrieval and content input to the current Web4.0 creating shifts in the dynamic stream of communication data flow from both human and non-human input [1]. From this input ITKS as a research framework can further interrogate the relationships between the individual trace and group trace data applied to local indigenous and larger collective knowledge spaces. From ITKS is the potential for efficiencies to sort, filter and re-structure data over-load by mapping the data communication trajectory and interactive-relationships within systems organizational agile shapes and structures [6]. From this divergence in raw data analytics, new understanding in observing systems, simulation through 'Digital twin' design and optimization for vision streaming can enhance Human interaction and emerging technologies [6].

Digital interaction between individual actors is able to transcend barriers of human to human interaction through developing sophistication in network interactivity augmenting capacity from AI driven efficiencies. To build on Daugherty and Wilson's 'Missing middle' approach [1], industry technology needs to address how human interaction can train AI through machine learning to compliment the leadership and creative empathy that human operators input. Machines have the potential to deliver speed, analytics, super strength and accuracy in machine and AI led transactions, adaptations and productivity. However human and machine hybridity can amplify and interact to augment Human-Interaction with a far greater and more embodied symbiosis in the relationships between human and machine [1].

Individual Trace in the Knowledge Space as a new approach can augment insights from the 'Missing middle' [1] to greatly enhance communication through AI. From an industrial perspective, focused on human interaction for the iterative improvement through design of systems augmenting production capacities and safety in the Oil and Gas production operations. Now timely and needing research to resolve due to growing data overload and the need for insights to improve search, retrieval optimization from increasingly diverse groups of stakeholders. The research also focuses on the deeper understanding of production efficiencies in emergent live stream data-flow to build 2nd order functionality in operations presenting a crucial data visualisation method in intelligent manufacturing [6].

Building on how data trails and trace enabled from human and non-human interaction, be it industry focused productivity or sensor driven AI through Machine learning between production and consumption capacities. From the perspective of

content consumption in the larger internet Knowledge Space mankind struggles to cope with the mass of data overload and data-exhaust. Data-lake repositories and archives are enhancing an emergence in data work-flow in unprecedented quantities from the ever-increasing streaming of data input. However there is a crucial need for customizable algorithms that can analyse, model, simulate and optimise data to develop agile schema structures and models for transforming raw data into productive insights and knowledge. Clarity from individual data streams, triggers and alarm calibration with capacity improvements are the goals for new insights. Using a range of transactions and streaming adaptations shifting finite responses to live monitored flow statistics. The comparisons to Social Media, and classification in interaction user-experience are gaining phenomenal technological shifts to now re-imagine and re-shape communication tool-kits [1]. The user experience in interaction between human to human in online environments and the potential of increased capacity working with the dramatic shifts in machine learning for human and machine hybridity through collective intelligence central to operational productivity opportunities. The issues in data overload requiring new thinking and a gap in knowledge for transforming data overload into Individual Trace in the Knowledge Space.

When exploring Second Order functions in human interaction and the design of emerging technologies Cybernetics and its circular observational loop of design improvability is a central approach. Designing the design through an approach both from the perspective of an iterative methodology and a rich innovative philosophy behind Web4.0. The circular approach of Second Order Cybernetics, observing the observing in the design feedback cycle being built into individual trace in operations, and in their system meshworks with Individual trace in indigenous Knowledge Spaces becoming central for the visualisation in feedback loops as forms of Circularity [5]. The aim being to learn how to make better decisions in the use of data-flow through an agile approach that enables interaction, repeated cycles of learning designed in to the methodology. From this method called the Iterative Design Development Cycle [6] improvements can be designed through phased aims and productivity efficiencies. Intuitive design enhancements for technology are better driven by second order feedback loops in systems design to build in more flexibility for learning and augmenting streaming improvements.

4 Discussion: Iterative Design Development Cycle (IDDC)

The development of the Iterative Design Development cycle [6] has derived from a mixed methods approach where the research is constructed from a ‘thinking through making’ philosophy, prototyping and gaining user-feedback to innovate insights. The design method developed from Eric Ries’s influential constructionist approach supporting an iterative learning cycle originating in digital based Business StartUp’s [8]. Ries’s methodology involves a Minimum Viable Concept (MVP) and Minimum Viable Product (MVP) being exposed to an early-adopter market to engage user feedback [8]. The Iterative Design Development Cycle [6] develops from a Co-design, action research and literature insights through a feasibility iteration with a Make cycle to Co-design and understand user needs and wants. Then iterated in a Usability Measuring

through user-testing, developmental prototyping and Review documentation. The practice of making prototypes rather than a priori as an approach from a theoretical approach [6]. The 'Build/Measure/Learn' iterative methodology [8] designed and developed creating a methods design toolkit involving feasibility, usability and improvability cycles in three phases: Make/Measure/Insights [6]. These interactive circular approaches evolving development through insights from live Use-case insights to inform a research development cycle. Data flow used constructively for re-imagining the design connecting data in dynamic systems. This new approach utilises Machine learning to process data-flow and identify assets through AI, then mapping the Trace within live data model streams.

5 Conclusion

The research in Individual Trace in the Knowledge Space originated from working in industry as a design consultant and experiencing a gap in knowledge around working with data insights and the global problem of data-overload. The trace of workflow from an industrial and experiential cultural trace in domestic perspectives as germination points for new visualisation tools, improved UiD and UX is needed plus a framework to explore individual trace is key in the growing Knowledge Space. Clearly there is a timely need for new knowledge to better understand, design and implement improvements to the data trails and trace that transform the aggregate efficiencies in both user experience for search and retrieval, supply and delivery and through interaction with data for greater user potential. It is possible that through improvements to visualisation methods in data harvest, intelligence and productivity efficiencies using a new ITKS framework that individual trace of data trails can be utilized in the emergence of new approaches in what is referred to as the 4th Industrial Revolution: Cyber-physical systems constructing the Knowledge Space through data-trace and the intelligence being created in the mushrooming 'always on' inter-connected Knowledge Space of 'the Cloud', 'Data-lakes' and Internet of Things.

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Make Me Messenger: Critiquing Children as Design Informants

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Abstract. A study, with 44 children examines ideas put forward by children who used a prototype chat application. It appears that the less the child enjoyed the app, the more ideas they proposed. Six of the children had no ideas for improvement, the remaining children contributed 41 unique ideas but only one of these was for a feature that was not commonly seen in fully fledged chat applications. This paper further analyses the outcomes and investigates reason or experience that motivated the children to come up with the ideas.

Keywords: Child computer interaction · App design · Mobile design · Informants · Chat

1 Introduction and Literature

The participation of end users in the design or evaluation of products is core to HCI and is considered an activity worth doing and worth reporting on. The inclusion of children in the design and evaluation of their technologies is considered especially valuable as they bring insights into product design and development that is from their own experiences, their own contexts and expressed in their languages.

Children think differently than adults as they are still learning about different aspects of the things around them. They are not only curious and inclined towards learning about the everyday world but also have critical cognitive skills involving scientific reasoning [1]. Due to this reason, child perspective research has increased in recent decades with an interest of listening to children's experiences and views with children being considered as the social actors in their own lives rather than the passive result of socialization. [2] argues how children can act as an active producers of research data which cannot be obtained by examining only adults. Others also debate that children have their own specialties, characteristics and peculiarities as historically, socially and geographically situated [3]. That is why research should be for and with children rather than on or about them [4].

Participatory methods with children became popular after the paradigm shift in the social study of children. Previously children were taken as subordinates of adults, considered as incompetent, developing, and wanting [5], the so-called paradigm shift situated children as competent social actors. [6, 7] strongly argue that children should be included in a research as active social actors by themselves rather than as a pre-adult (waiting to be competent).

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Therefore, given this change, there are many papers that describe work with children as informants to research and design work. These typically describe either a new way to work with children, [7, 8] be it in design or in evaluation, or they describe how children actually contributed to the ideation or creation of a product or system by narrating how ideas come from children either during evaluation or design [9, 10]. Many papers especially reflect on the inclusion of children from marginalized or non-typical groups [11, 12]. Sometimes researchers use children as co-researchers to clarify an existing idea or theory or to discover the children's perspective. For example [13] worked with children to research on the subjective well-being in residential areas.

[14] explained in their paper that participatory methods for children to contribute to design are beneficiary. However, on the other hand, children designing something for a population that might have grown up in a completely different culture is a completely different scenario which is really interesting to look at. In research done by [15], children were asked to design a game for other children but actually they were designing for themselves. The study showed how the children can involve themselves in design processes in participatory design.

The aim of this present study is to examine whether or not, and to what extent, children could provide useful feedback on a partly designed app and could contribute design ideas.

2 Method

2.1 Participants

The study took place in a lab of a University over two days where 44 children aged 9–11 participated. The work had been approved by the University ethics committee and children consented, as did their parents, to participate in the study. Children were told before and after participation that they could personally also withdraw their consent and their data. No children took this option.

2.2 Apparatus

The study required two products to be made, the first was a functional basic prototype that could be used to introduce how a chat app might look, the second was a data collection form. A basic app was built on the Android platform that allowed children to register, login and chat with a selected friend. The app development is part of a larger project where the intention is to develop a child friendly chat app that will allow communication between children in different time zones, different cultures and different languages.

The second was a three-page data collection form with two smileyometer, inspired by the work of [16], and one feedback page which the children will fill themselves during the activity. The three pages of the form were therefore as follows:

- Page 1: Before using the app, rate, using the Smileyometer, how good the chatting app will be?
- Page 2: After using the app, rate it again on the Smileyometer.
- Page 3: Add ideas that will make the app better

2.3 Procedure

The children came to the study in teacher constructed groups of 4 or 6 children. The researcher explained the experiment to the children what their role would be in this study. To ensure the children were comfortable doing the activity and were familiar with how chat apps worked, the researcher had an informal chat with the group about apps that they knew about.

Now each child was given the first page of the data sheet to complete where they were asked to predict how good the app, that they were about to use, would be. After every child had filled this in, each was given an identical mobile phone, with the chat app installed, and was asked to register (they could use any name they want). Having registered, each then chose another child to pair up with and began to chat with one another. The children were given 10 min of time to chat and were encouraged to talk about anything. After 10 min of chat, they came back to the paper and filled out page 2, where they reported on their experience, and then onto page 3, where they reported design ideas. If, having completed the sheets, there was any time left, they were allowed to return to the app and continue chatting. As each group left the room, the researcher signed them out of the app and got the room ready for the next group.

3 Results

3.1 Opinions of the Children

The opinions of the children, of the app were gathered by collecting before and after Smileyometer data which allows some analysis as to whether children were disappointed satisfied or impressed. Applying a score from 1 to 5, with 1 being the least fun, the average rating for the app before using it was 3.62 and after was 4.46 which shows that overall the children found the app better than they expected. 38 of the 44 children rated the app 5 out of 5 after using it. They really enjoyed the activity and thought that the app is really good too.

Whilst most of the children raised their scores from their first impression to the experience, two of them dropped their scores from 3 to 2 and 5 to 4. These two gave 3 and 5 ideas respectively to improve the app.

3.2 Ideas from the Children

Concerning the ideas given by the children to improve the app, a total of 134 ideas were written down which resulted in 41 unique ideas. With 44 children, these numbers represent an average of just over three ideas per child but an average of unique ideas of less than one per child.

Of the ideas that were given by more than one child, the most mentioned was for the inclusion of emojis. Other popular choices are shown in Table 1.

Table 1. Most stated ideas

Idea	Frequency (number of children)	Percentage
Include emoji's	38	86
Include picture	12	27
Group chat	8	18
Phone calls	7	16
Video calls	6	14

Even though the sheet given to the children prompted them for 7 ideas, most children gave between 2 and 3 ideas, 2 gave more than the sheet asked for and 6 gave none. Of the 38 children that gave ideas, 27 of these ideas were ideas that no other child gave. That is to say, these ideas were not repeated in the corpus of ideas. This suggests that the children were thinking independently.

Some children misunderstood what was being asked for on the ideas page with 5 of them using the space to write things like 'amazing', 'really good' and with 7 giving ideas that did not relate to the app like 'tells you what to do', and 'read other people' which, with interpretation could be morphed into design requirements but were really not formed enough to be implementable or useful ideas. Five ideas were not able to be deciphered.

4 Discussion

The discussion on the ideas provided by the children can be approached in two ways, firstly to consider the value of the activity in providing design ideas and then to consider what influences the 'production' of ideas.

4.1 Value of the Ideas

It is worth to analyze whether the ideas given are worth implementing in the app. This is a coarse way of rating their 'usefulness; as it is the intention to develop the app further and so this process was not just a paper exercise. The developer of the app classified the ideas from the children in terms of their use for the next iteration. This classification is seen in Table 2.

Table 2. How ideas may be used

To add	Might add	Out of scope	Unrelated
Emojis, send pictures, games to play with, take photo	Add friends, profile picture, send videos, delete message, send music, send gifs	Face filters, bunny ears, unicorn colours, group chat, phone calls, video calls, send voice messages, RATE message	Eating and dining

4.2 Critical Children and Ideas

The children nearly all loved the app (according to Smileyometer scores) but still were able to think of improvements. We were interested to understand if there was any correlation between being unhappy with the app and the number of ideas generated. Three correlations calculations were done but none of which are strong.

Correlating the score given before using app with the number of ideas given showed a weak negative relationship with a coefficient of −0.42. The score after vs number of ideas had a moderate negative relationship (−0.55).

These correlations suggest there may be some possibility that the number of ideas rises according to the 'opinion' of the app. The relationship is not that strong because in some cases, even when rating the app as 5, children gave 6 or 7 ideas. However, it was interesting to see that 2 children who rated the app as 2, after using it, each gave 8 and 9 improvement ideas and that all the six children who gave no ideas rated the app 5 after using it.

4.3 Influences of the Design of the Session on Ideas

The ideas from the app were examined to identify what might motivate the idea. Three motivations were identified: (a) other apps, (b) limitations from the prototype and (c) the experience of typing. Table 3 clusters ideas against these motivations.

Table 3. Influences on ideas

Other apps		Prototype limitations	Typing
Face filters	Send videos	Make emojis work	Emoji
Make bunny works	Group chat	Type and send long messages	Shortcut
Unicorn colours	Profile picture	Send voice messages	Rainbow
Phone calls	Snapchat	Delete message	Writing
Video calls	Games to play		
Send music	Delete message		
Send voice message	Send gifs		
Rate a message	Font colour		

From this analysis it appears that using the app did not in itself motivate very many design ideas however it is not possible to say whether the same study without the use of the app would have flushed out all the ideas that we have, in this analysis, attributed to other app knowledge as the 'act' of using the app and being in a chat interface may have been important in helping the children to think about other apps they have encountered.

4.4 Children as Design Informants

What can be learned from this study about children as design informants? Children can provide feedback and critique on the software developed for them as active contributor as explained in [2, 3, 5]. They were also able to suggest some useful ideas to improve the app and make it suitable for them. This shows how children can act as actors of this research being informants for the design of the app similar kind of observation found in [14, 15].

The development of the app is ongoing and the children who contributed to this work will be able to see the newer version of the app when it is ready. They will also be asked to comment on the research finding.

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Reduce Stress Through Empathic Machine to Improve HCI

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Abstract. Daily life problems, can lead to distress, which has a harmful effect on health. Individuals are using machines for longer period. Machines should now have the ability to understand and show empathy which relies on trying to help the other through their emotional situation. In this study, showing empathy is done by reducing the effect of negative stress by using blue light. In the experiment, 17 participants executed a computer-mediated stress-generating test while using an Empatica E4 to extract physiological signals. The test is done without and with additional blue-colored light. The results show that a simple addition of blue colored light has the tendency to reduce mental stress. That can be interpreted as, compared to the normal state, the experiment with no light-induced more stress than the experiment with the blue light in the humans. Which imply that the blue light helped in maintaining a lower level of stress.

Keywords: Human computer interaction · Empathy · Stress · Light · Color

1 Introduction

Nowadays many jobs are requiring the usage of machines and this number is yet to increase over the years in addition to social media and entertainment. People are spending long hours on their phone, laptops and other kind of machines, for example Britons spend an average of 8 h and 41 min on media devices per day as mentioned in the BBC news in 2014 [1]. This is why the aim should be towards making the use of technology as relaxing and pleasing as possible. The machine should be able to show empathic capabilities and understand its users and their needs. Daily life problems, constituted of pressure at work, social pressure and the fast-paced world in general, can lead to stress. There are two kinds of stress. The positive stress, called *eustress* and the negative stress, called *distress*.

Eustress can motivate and help humans to be more productive. When the demands that are placed upon an individual (physical or psychological) are too high, the performance starts to decline and the individual starts to experience negative stress, which is called distress. Distress can make us feel sick [2], greatly reduce productivity or even

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lead to depression and burnout [3]. There are different ways to let a machine show empathy. One example are empathic companions, which are robots or virtual agents with human like capabilities [4], another can be empathic chatbots that generate empathic responses used to diagnose and treat mental illnesses in the Swiss Health Observatory [5]. Other ways that can be used are light and color, which impact the emotional state of humans [6, 7]. The intention is to create a system that reduces stress by understanding how the user feels and then gives him an empathic response when stressed. The experiment is conducted to use light and color as an empathic response.

2 Related Work

In this section an overview of the related research is given. First, a summary of effects of light on human emotions in general, second how colors affect them. Further, a way to generate stress is needed and an overview of stress generators will be presented.

2.1 Light and Color

Light can have various effects on humans [8]. For example, the presence of light has an impact on mood and well being, it is important to note that various colors of light can also have a different effect on the mood and the emotions [6]. The light frequency also has an effect on humans mood and emotions. For instance, static light has a greater impact on stress reduction than pulsating light [7, 8]. These colors affect the person subconsciously, which means that it works without the person being aware of it [9]. In general, short-wavelength colors like green and blue are less arousing than long-wavelength colors like red and yellow [7]. For example red is described as stimulating, friendly and lively [10]. Red is also attributed with high levels of compliance and that it improves the performance on detail oriented visual tasks [8, 9]. Blue has a soothing effect on humans and mostly affects the mind rather than the body. Especially soft blue color is attributed with calming down whereas stronger blue improves the clearness of thoughts [10].

2.2 Stress Generation

In order to test the stress reducing capabilities, first a way is needed to generate stress. There are a few key points which are commonly used and proven to create stress [11, 12]:

- Cognitive stressor: Any task that is mentally challenging to the participant. For example mental arithmetic [12].
- Social pressure: Evaluation of the performance of the individual, in particular by an external person. For example a job interview. This has been found to increase the cortisol response, heighten the electro-dermal skin activity and also the subjective stress response [13].
- Timing pressure: A maximum amount of time is given to complete the task [11].

- Random events: Generation of random events that could disturb the main user task like sudden noises, changing background, changing position. Alone the fact that the outcome of what the participant is doing is not predictable, greatly increases the stress [13].

Various approaches incorporate one or more of those stressors to create a task that induces stress in participants. One that is frequently used is the trier social stress test [14] (TSST). The TSST creates an artificial job interview situation in which participants are told to prepare a presentation for some experts.

Another task that has the tendency to increase stress is solving math questions. Calculations in quick succession has been found to reliably induce acute mental stress [12, 15]. In the arithmetic task, participants solve math equations as quickly as possible with time pressure and observer feedback [15]. The most implementations of the mental arithmetic task contain the following elements: Immense time pressure for the questions, loud feedback sound, oral feedback of the experimenter and auto adjusting questions to keep the task difficult.

2.3 Synthesis of the State of the Art

There is a lot of work about the effects of colors and light, but only under very specific conditions. For example, a whole room painted in a specific color [16], or a whole room with only red colored light, and no other light sources [17]. This is not very applicable to an everyday work situation. Especially where multiple people are in the same room, because not every person needs the same color of light. The goal is to see if it is possible to reduce stress in an everyday office work environment, with light that could be locally set up at every workers workplace. To see the feasibility, an experiment is conducted where the computer executes a stress protocol, which mentally stresses the participant, while he interacts with it. The idea behind this is to simulate a stressful situation in the daily office life of a worker. During this interaction an empathic response, which consists of blue colored light, will be given to participants. This is to attempt to calm down the participants subconsciously without them noticing any change in their workflow and without being interrupted.

3 Experiment

In this section, the specifics of the experiment are described and how it was executed. To add the additional blue colored light during the experiment, several light sources were used. The lights used are two Philips hue Bloom, one Philips hue light strip and a set of Nanoleaf panels. The physiological signals were detected using an Empatica E4. The experiment architecture can be found in Fig. 1.

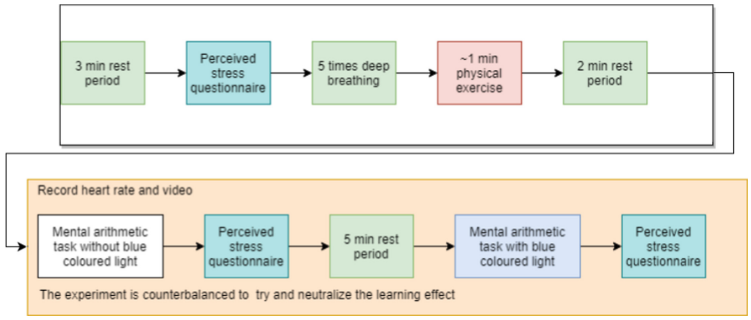

Fig. 1. Experiment architecture

The mental arithmetic task experiment uses a combination of all commonly known stressors: Cognitive stressor, social pressure, timing pressure and random events. The task starts from a random big prime number between 5000 and 8000. The challenge is to subtract seven or thirteen from the number in quick succession. The number is chosen randomly at the start. The time participants have for a single answer starts at five seconds and the whole task lasts eight minutes. Whenever a correct answer is given, the available time for the next answer decreases by one second. On the other hand when a wrong answer is given, a loud buzzer sound is played, the screen flashes red very briefly and the participant has to restart from another random big prime number with either 7 or 13 chosen randomly again. In addition, the timer for the next answer increases by one second. The maximum time for an answer is 20 s.

To further stress the user a random and social pressure elements were added. For the random events two ways were used, either if someone gave more than four correct answers the number that they had to subtract changed randomly to either 11, 17, 19, 23 or 29 and 2. Alternatively, if people let the timeout happen more often, the timer that shows how long they have left for an answer, started to fade out until it was invisible. It starts to reappear again when the participants answer correct answers. For the social pressure part people were told that they are being recorded to later be evaluated by experts, the experimenter walked around behind the participants, and took notes by pen and told them that they perform below average from time to time.

Seventeen participants (ten males and seven females, age range from 21 to 63) took part in the experiment. The study uses a within group design (as seen in Fig. 1). The experiment is counter-balanced, to counteract the learning effect, the two conditions are one. Mental arithmetic task with no-light condition and two. Mental arithmetic task with blue-light condition.

4 Results

The experiment was executed with seventeen participants. Nine started with the no-light condition and eight started with the blue-light condition.

The use of a Kolmogorov-Smirnov test and a Shapiro-Wilk test indicates that the data is normally distributed. Thus, a paired samples t-test is used for the statistical

analysis. As the HRV measure, the RMSSD is calculated. A low value means more stress and a high value means less stress. It would be desirable to have a higher value during the blue-light condition and a lower value during the no-light condition.

Results show that for the RMSSD average value is 0.2923 with blue light and an average value of 0.2695 without light. The baseline is 0.342. The value of the blue-light condition is higher than the one of the no-light condition. This shows that the condition with blue light successfully prevents stress generation, when compared to the no-light condition.

Another way to analyze the results is to compare the baseline values to the values of the no-light condition or the blue-light condition respectively. The comparison is done using a t-test. The comparison of the blue light condition to the baseline yields a p-value of 0.072 for the RMSSD value higher than 5%, which means that the blue light helped the participants to reduce their stress by not allowing the stressor to be significant. The comparison of the condition with no additional light to the baseline gives p-values of 0.022, which is lower than 5%. This means that under the no-light condition, participants got stressed significantly by the task. This is also an indication that blue light helps to reduce mental stress.

In addition, a perceived stress questionnaire was used for self-assessment by the user. It shows that the participants under the blue-light condition reported lower stress scores than under the no-light condition. Which is complementary to the t-test results of the physiological results and show that additional blue colored light to reduce stress.

5 Conclusion

In this technological society, a lot of the interaction is with machines, improving this interaction is necessary. Moreover, mental and physical health are important issues. Reducing stress can help and be a solution for this kind of problems. Empathic machines with such integrated features can be the answer. The idea is to reduce stress without taking away the attention from the current task. The experiment done was by using blue colored light. In the experiment, mental stress was induced in participants by a mental arithmetic task. Results show that the blue colored light reduces stress in participants and keep them calm as their normal state, in contrast to the no light condition where people have were significantly stressed.

Further steps and development will follow this research, starting by increasing the number of participants to have more labelled data. Other colors, like red green and yellow will be investigated to study its effect on stressful situations and other kind of context. This research can be used in autonomous cars, public transport, offices and other areas where the human is facing stressful situation in the goal to be able to have a sane mental and physical health.

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App Use While Phubbing

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Abstract. Existing research on phubbing focused mainly on the effect of phubbing on individuals' wellbeing and social relationships. No published work has investigated in detail which apps are commonly used by smartphone users while having a face-to-face conversation with others and which demographic characteristics influences the choice of these apps. An online survey of 385 participants revealed that that Facebook was the most frequently used app by smartphone users while they are having a face-to-face conversation with others and that participants were more likely to use Facebook, Facebook Messenger, and Apple/Android Messages than Whatsapp, Pinterest, LinkedIn, Skype, WeChat, and Tumblr while having a face-to-face conversation with others. Results showed that an increase in age was weakly associated with a decrease in the use of finance apps (internet banking); social networking apps; photo and video apps; music apps; news apps; and lifestyle apps (Tinder) during phubbing. Results also showed that only two significant differences in the scores for males and females across the app categories used during phubbing were found and that there was no significant difference in the scores of urban and regional participants across the app categories. Considering this is the first study of its kind that looked in detail at which apps are commonly used by smartphone users while having a face-to-face conversation with others, a follow up study should next be conducted using qualitative interviews to understand in depth why do people use these apps and not others while having a face-to-face conversation with others.

Keywords: App use · Phubbing · Smartphone

1 Introduction

The behaviour of engaging with the smartphone instead of paying attention to the physically co-present person is called phubbing and can be defined as the act of snubbing someone in a social setting by looking at the smartphone instead of paying attention to them [1]. No research has focused in detail on which apps are commonly used by smartphone users while they are having a face-to-face conversation with others. The current study seeks to address this shortcoming in the literature. The study addresses the following research questions: Which apps are smartphone users more likely to use than others while having a face-to-face conversation with another person or persons? Which participants' demographic characteristics influenced the choice of apps during phubbing? The study is significant because it is the first study of its kind

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that looks in detail at which apps are commonly used by smartphone users while having a face-to-face conversation with others.

2 Related Work

Limited studies have examined app use while phubbing and app use in general. However, those studies that exist, particularly in the first case, have a number of shortcoming that weaken their ability to inform this study's hypotheses. For studies investigating app use while phubbing these limitations revolve around the sample sizes used (low to mid hundreds), the locations where the studies were conducted (developing countries, one non-Western), the demographics of the samples (focus on university students not adults) and the limited apps examined. For studies investigating app use in general these limitations revolve around the type of apps studied, and the fact that these studies do not focus on app use while phubbing. That said, apps used while phubbing are expected to be similar to those used in general; with the additional criteria being apps do not require sustained attention, a characteristic of most apps.

Angeluci [2] surveyed 101 Brazilian university students about, amongst other things, what behaviours in which they engage while phubbing others. Results showed that the behaviours in which participants most commonly engaged while phubbing were 'chatting/texting with friends' (91%) and 'posting something on social networking platforms' (61%), with 'watching a video' being the least common. Angeluci felt this may be due to the fact that texting and posting on social media are less disruptive than watching a video. Davey et al. [3] surveyed 400 Indian university students on their attitudes and experiences towards phubbing, including what mobile apps they use while phubbing. Results showed that the social media apps most commonly used by participants while phubbing were Whatsapp (33.5%), followed by Facebook (28.9%), LinkedIn (21.9%), Twitter (10.6%), and others (5.1%). A study by Deloitte found that the types of apps most frequently used by users were social media apps (59%), weather apps (52%), web browsers (46%), and gaming apps (41%), followed by music streaming apps (37%), banking apps (34%), navigation apps (33%), and retail/shopping apps (32%). These findings support those from an earlier study by Deloitte which found that the apps most frequently used by users were social media apps (55%), followed by weather apps, gaming apps, banking apps, navigation apps, and browser apps.

In terms of differences, a study by Logan [4] found that respondents were more likely to use social media apps than any other type of apps (e.g., music apps, video apps). Chan [5] supported these findings. No studies have looked at differences among app types. With regards to social media, a more recent study by Deloitte found that the social media and messaging apps most commonly used by users were Facebook (77%), followed by Facebook messenger (62%), Whatsapp (30%), Instagram (27%), Skype (28%), Twitter (22%), Snapchat (19%), and WeChat (9%). In contrast, an earlier study found that the social media apps most commonly used by users were Facebook (92%), Instagram (28%) and Twitter (24%). The finding that Facebook is the most frequently used social media app is supported by a number of other studies, including by the Australian Psychological Association, Sensis, and the Pew Research Center. No known

studies have looked at differences between social media and/or messaging apps. In the face of the above, the first and second hypotheses are: Hypothesis 1 (H_1): Participants will most frequently use social media apps while phubbing. Hypothesis 2 (H_2): Of the social media apps, participants will most frequently use Facebook and Whatsapp while phubbing. The influence of participants' demographic characteristics on the choice of apps during phubbing has not been studied yet. Therefore an open research question is posed: RQ1: Which participants' demographic characteristics influenced the choice of apps during phubbing?

3 Method

Data was collected using an online survey which was administered using SurveyMonkey. Three hundred and eighty-five participants were recruited via social media, the author's university daily email newsletter, a media release by the author's university, newspaper and magazine articles advertising the survey. Participants were considered eligible for inclusion in the study if they were 18 years of age or older and owned/used a smartphone. The mean age of participants was 41.04 (*SD* = 13.30, *Mdn* = 40.00, *range* = 18–72). Other demographic characteristics of participants are shown in Table 1.

Table 1. Demographic characteristics of participants

Variable	Frequency	Percent
Gender		
Male	101	28.37
Female	253	71.07
Country of residence		
Australia	345	96.64
Area		
Urban	169	47.47
Rural	187	52.53

App use while phubbing was examined by asking participants, on a scale of 1 to 5, where 1 equals *never* and 5 equals *all the time*, how often they look at the apps listed in Table 2 while having a face-to-face conversation with another person or persons. This list of apps was derived from Apple and Android (Google) top lists and Australian social media reports [6, 7].

Data was analysed using SPSS. Descriptive statistics were generated for all variables. Items in the 'apps used while phubbing' question were assessed using a Friedman test with post-hoc Dunn-Bonferroni tests. Items were first examined individually and then grouped into categories (and then examined within and across categories). Table 2 shows these categories. These categories represent those used by Apple in their app store and are chosen by developers when they first submit their app/s (and can be changed upon the release of new app versions). A Spearman's rank order

correlations were used to assess the relationship between age and the app categories used during phubbing. Mann-Whitney U tests were used to assess gender and app categories and area (urban vs. rural) and app categories.

Table 2. App categories

Category	Apps
Social networking	Facebook, Facebook Messenger, Skype, Whatsapp, Pinterest, LinkedIn, Tumblr, WeChat, and Apple/Android Messages
Photo and video	Instagram, YouTube, Snapchat, Apple/Android Photos, and Flickr
Weather	BOM Weather and Apple/Android Weather
Entertainment	Netflix
Music	Spotify, SoundCloud, Apple/Android Music, and Google Play Music
Travel	Uber, TripAdvisor, and Yelp
Navigation	Google Maps
Utilities	Web browser (e.g., Safari, Firefox)
Productivity	Gmail, Outlook, Apple/Android Mail, Wordpress, and Blogspot
News	Twitter and Reddit
Finance	Internet banking app
Lifestyle	Tinder

4 Findings

A Friedman test was carried out to compare phubbing frequency scores for the 12 categories of apps (utility, navigation, finance, social networking, weather, photo and video, productivity, music, entertainment, news, travel, and lifestyle). There was a significant difference between the categories, $\chi 2(11) = 1386.658$, $p < .05$. Dunn-Bonferroni post hoc tests were carried out which showed significant differences among the pairs. Participants were more likely ($p < .05$) to use utility apps (i.e., web browser; Mdn = 3.00), navigation apps (Mdn = 2.00), finance apps (Mdn = 2.00), social networking apps (Mdn = 1.56), and weather apps (Mdn = 1.50) while phubbing than lifestyle apps (Mdn = 1.00), entertainment apps (Mdn = 1.00), travel apps (Mdn = 1.00), news apps (Mdn = 1.00), and music apps (Mdn = 1.00). They were also more likely to use utility apps (Mdn = 3.00), navigation apps (Mdn = 2.00), finance apps (Mdn = 2.00), and weather apps (Mdn = 1.50) than productivity apps (Mdn = 1.40). In addition, participants were more likely to use utility apps (Mdn = 3.00) and navigation apps (Mdn = 2.00) than photo and video apps (Mdn = 1.40), finance apps (Mdn = 2.00), social networking apps (Mdn = 1.56), and weather apps (Mdn = 1.50). For more information about these relationships see the ordered medians in Table 3.

With regards to social networking, participants were more likely to use Facebook (Mdn = 3.00), Facebook Messenger (Mdn = 2.00), and Apple/Android Messages (Mdn = 2.00) than Whatsapp (Mdn = 1.00), Pinterest (Mdn = 1.00), LinkedIn

Table 3. Median scores for 'apps used while phubbing' item categories

Categories	Median
Finance apps (internet banking)	2.00
Social networking apps	1.56
Weather apps	1.50
Photo and video apps	1.40
Productivity apps	1.40
Music apps	1.00
Entertainment apps (Netflix)	1.00
News apps	1.00
Travel apps	1.00
Lifestyle apps (Tinder)	1.00
Utility apps (web browser)	3.00
Navigation apps (Google Maps)	2.00

(Mdn = 1.00), Skype (Mdn = 1.00), WeChat (Mdn = 1.00), and Tumblr (Mdn = 1.00) while phubbing. Participants were also more likely to use Facebook (Mdn = 3.00) and Facebook Messenger (Mdn = 2.00) than Apple/Android Messages (Mdn = 2.00).

A Spearman's rank-order correlation was run to assess the relationship between participants' age and app categories used during phubbing. Results showed a weak negative relationship between age and finance apps (internet banking); age and social networking apps; age and photo and video apps; age and music apps; age and news apps; and age and lifestyle apps (Tinder). The results mean that an increase in age was weakly associated with a decrease in the use of these app categories during phubbing. The only app category that its use during phubbing increased as age increased was the weather apps category. This positive association is also weak. Mann-Whitney U tests were conducted to see if there was a significant difference in the scores of males and females across the app categories used during phubbing. Results showed only two significant differences in the scores for males and females. There was a weak negative relationship between gender and finance apps (internet banking); and gender and photo and video apps. Mann-Whitney U tests were conducted to see if there was a significant difference in the scores of urban and regional across the app categories used during phubbing. Results showed there was no significant difference in the scores of urban and regional participants.

5 Discussion and Conclusion

The purpose of this study was to investigate the apps that smartphone users use while having a face-to-face conversation with others. H_1 stated that participants will most frequently use social media apps while phubbing. The statistical analysis confirmed that this hypothesis is only partially supported. The study found that participants were more likely to use utility and navigation apps while phubbing than any other app, and

finance, social networking and weather apps than most other apps. These findings also partially support previous research by Deloitte, which found that these app types were all amongst the most frequently used but in a slightly different order, with social media apps at the top. The reason that social media apps were not used more frequently while phubbing than any other app is likely due to the mean age of participants in this study (41.04); as these studies have shown that older people use social media far less frequently than younger people.

Within the social networking apps, the analysis confirmed H_2 with regards to Facebook. The study found that Facebook was the most frequently used app while phubbing, and Whatsapp was the fourth, and that participants were more likely to use Facebook, Facebook Messenger, and Apple/Android Messages than Whatsapp, Pinterest, LinkedIn, Skype, WeChat, and Tumblr while phubbing. They were also more likely to use Facebook and Facebook Messenger than Apple/Android Messages. The former finding is partially supported by previous research, and thus also partially supports H_2, while no literature yet exists to support or refute the latter significant finding. These findings could be used to inform 'stop phubbing' programs, policies and campaigns.

In terms of the open research question regarding the influence of the participants' demographic characteristics on the choice of apps during phubbing, results showed that an increase in age was weakly associated with a decrease in the use of finance apps (internet banking); social networking apps; photo and video apps; music apps; news apps; and lifestyle apps (Tinder) during phubbing. The only app category that its use during phubbing increased as age increased was the weather apps category. But this positive association was also weak. Results showed only two significant differences in the scores for males and females across the app categories used during phubbing. There was a weak negative relationship between gender and finance apps (internet banking); and gender and photo and video apps. There was no significant difference in the scores of urban and regional participants.

The study makes a key contribution to the literature in that it is the first that looked at which apps are commonly used by smartphone users to phub others and which demographic characteristics influenced the choice of these apps. A follow up study should next be conducted using qualitative interviews to understand in depth why smartphone users use certain apps over others to phub other people.

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Optimization for Collaborative Learning Environments by Matching Team Members with Analyzing Students' Various Data Using ICT

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Abstract. The aim of this study is to optimize learning environments for collaborative activities through interactive communication by combining members of small groups. It was supposed that supervisors or tutors might be difficult to fix members, matching new students for collaborative learning, especially in a case of utilizing ICT. As one of solutions for those problems, we have developed the support system which provides them the method of combining team members, along with students' types of traits measured by YGPI (Yatabe-Guilford Personality Inventory). The result of students' performances in 2015 was shown significantly better than those of 2014. This phenomenon continued in the first semester, however, it has been gradually down in the second semester comparing with those of 2015. Then, we have introduced another method of combinatorial optimization in 2019 by analyzing various students' data, for example, factor scores of traits, performances in class, report, observations, and so on. From the finding of those investigations, we have divided into successful and unsuccessful teams in order to specify factors which might have an effect on collaborative learning with interactive communication. After brief course of instructions which requires supervisors to focus on factor scores of O (Objectively), Co (Cooperative) and T (thinking introversion), we have asked them to optimize combination of team members for new students in April, 2019, because those factor scores were significant variance among five years in collaborative learning environments. At the present time, we have recognized an effect of the optimization, observing that their performance becomes significantly better than those of previous year. There are remained problems concerning with combinatorial optimization, because of various discrete elements in Education, especially using ICT. Therefore, those studies would be required continuously to gather various data and analyze them in order to improve the method of matching members for interactive communication, which might be useful references for combining members automatically by AI in certain conditions.

Keywords: Interactive communication · Environments of collaborative learning · Combinatorial optimization · Various students' data · Analyzing big data processing

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1 Introduction

Aging society with fewer children has become serious nurse shortage in Japan. In addition to lack of medical personnel, they have been beginning to be required to acquire high skills and abilities, along with development of Internet connected medical device. From those reasons, in the field of nursing science Education, ICT has been introduced, especially CSCL (computer supported collaborative learning), so that instructors can not only cultivate student capable technology, but also communicable skills.

That must be the best selection of means to improve Education of nursing sciences effectively. Reality, however, it was reported that there were signs of emerging problems that some students had hesitated to practice with other members of their team in class. On the other hand, some researchers, who have already studied about CSCL, had reported similar difficulties because of various elements concerning with it [1]. As a result of accelerating the speed of communication from distance with devices through Internet, it might have made difficult for students to interact smoothly in small groups.

It was supposed that they might have been difficult to know with each other, for instance, their characteristics, preferences, traits so on, which were very important elements of mutual understandings. Therefore, we have focused on the combination of members who are able to interact smoothly in small group for collaborative learning by using YGPI (Yatabe - Guilford Personality Inventory) [2] so that instructors can design instructions for students in optimized environments of collaborative learning.

YGPI is one of the most popular psychological testing because its structure is constructed by twelve factors (D, C, I, N, O, Co, G, Ag, R, T, A, S) and has been standardized by five levels each and verified high reproductive and reliability. In addition to this, those levels have been visualized Big Data processing by each personnel profile which is illustrated a percentile curve with the points of rank for twelve factors each. Moreover, this profile is not only shown visually each student's characteristic, but also categorized into types of her/his personality, for instance, A, B, C, D, E types. This means that even if practitioners had not enough psychological knowledge, they would have been able to comprehend their students' traits visually.

2 Design

2.1 System

Objectives of importance to optimization for collaborative learning environments is to improve personalized education. In other words, when we think about learning environments for individual students, along with their needs, goals, traits and preferences, those of members who are addressing problems with them must have effects on their performances. That is, whether instructors can keep quality of education for students or not would be depended to a large extent on how they will divide students into small groups for collaborative learning.

In real society, there must be a lot of opportunities that people should work with persons who might not work with them willingly. Some papers have reported that those

problems, concerning with relationships with co-workers, might have become uses to leave their job. That's why students need to have a good experience successfully with optimized members through problem solving in collaborative learning class. From those reasons, we have developed PELS (Personalized Education and Learning Support System) [3] in order to help instructors to combine members appropriately, utilizing the results of YGPI.

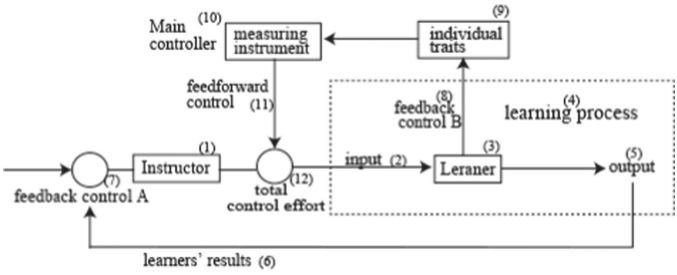

Fig. 1. PELS (Personalized Education and Learning Support System) [3]

Before instructors (1) (Fig. 1) begin a lecture (2–3), they need to design their class (4) including the members of small groups considering with students' needs, traits (8–9) and so on. It is supposed, however, that it is difficult for instructors to consider about individual traits, especially for new students, because they have not obtained their records yet (4–7). Therefore, we support instructors by measuring students' traits, gathering and analyzing other various data (8–12) so that they can design appropriately their class activities and members of small groups.

2.2 Model of Optimization

As mentioned previously, it is easy for instructors to understand results of YGPI, because they are described by types, for instance, A, B, C. On the other hand, it was supposed that combinatorial optimization [4] might be difficult because of various discrete elements. Therefore, the method of local search for solution (Fig. 2) have been adopted approximately for matching members of small groups along with analyzing students various such as learning process, traits, reports, and so on.

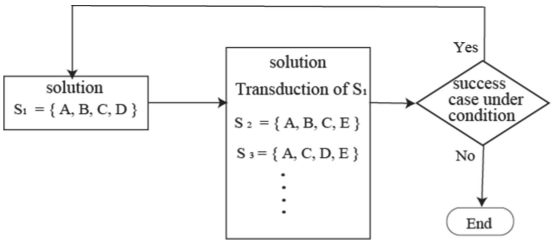

Fig. 2. Local search for solution of combinatorial optimization

2.3 Hypothesis

The problem solving in combinatorial optimization has been conducted by the model of Local Search (Fig. 2) from 2014 to 2018 based on empirical values of instructors, according with the scaling up method; design – implement – evaluate – redesign cycle. It is shown the results of achievement tests comparing over the years (Fig. 3) so that we can find problem remained currently. Comparing results of the first semester between the year of 2014 (by the traditional method) and 2018, it is considered that there must be a significant improvement, bur in the second semester. In other words, the other problems for the combinatorial optimization must be remained to improve collaborative learning.

Instructors have been provided individual students' profiles which were also described scores of twelve factors. If they understand those meaning, they might be able to find the next solution.

Then, we have formed a hypothesis and prove a theory below;

(1) Some scores of factors are different from each other depending on academic years.
(2) A Solution of problems would be found out from the results of 1.

From those viewpoints, after the investigation of students' various data in order to analyze differences or correlations from 2014 to 2019, the teacher training has been conducted so that instructors would be able to understand scores of factors and match members of small groups based on their experiences and results of analysis.

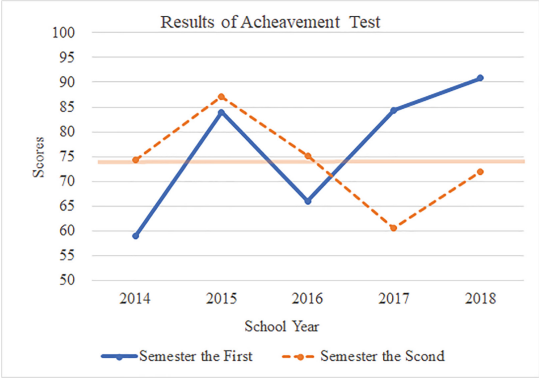

Fig. 3. Comparisons results achievement tests from 2014 to 2018

2.4 Methods

2.4.1 Methods of Experiment

(1) Investigation
Analyze students' various data from 2014 to 2019 which had been gathered at the nursing science education of K university (the total number of students is approximately 550), in order to find out problems regarding with combination of members.

(2) Teacher Training
Consult instructors how to understand the score meaning factors and propose success and unsuccess groups from the results of investigation.
(3) Implementation
Conduct the experiment in collaborative learning class along with decided members of small group redesigned by instructors and gather their data, especially, regarding with the reform.

2.4.2 Method of Analysis

(1) Quantitative Analysis
Compare scores of factors and find out the correlation with other various data in class.
(2) Qualitative Analysis
Observe class activities in 2019 and find out relations with the results of quantitative analysis.

3 Results

3.1 Results of Investigation

From the results of investigation, there were found out significantly differences regarding with the Factor Scores; RF ($F = 2.28$, $p < .10$), CO ($F = 3.44$, $p < .001$), SC ($F = 3.00$, $p < .05$). Because those factors are related to T (Thinking Extroversion) (Fig. 4), Co (Lack of Cooperativeness) and O (Lack of Objectively), the potions of each level have been illustrated by graphs so that we can compare them easily. The feature of Level 5 is stronger than that of lever 1 in each factor.

From the results of O factor, the feature of Lack of Cooperativeness is stronger in both 2016 and 2019. Regarding to T factor, the feature of extroversion has been gradually decreased from 2015 to 2019. In other word, the feature of introversion is stronger in 2019. Concerning with the feature of subjectivity, students in 2015 and 2016 are stronger than others.

3.2 Results of Experiment

From the results of participated observations, students have been continuously addressing a problem with positive attitudes collaboratively. Their communication among members were quite interactively and smoothly, comparing with other academic years. The ratio of taking out reports and other assigned were quite high.

On the other hand, one of twenty-five teams in 2019, there was reported that one student has been dropout and another one has been frequently absent.

4 Discussion

We have been challenging combinatorial optimization so that students can study under the acceptable conditions, in other words, learning environments.

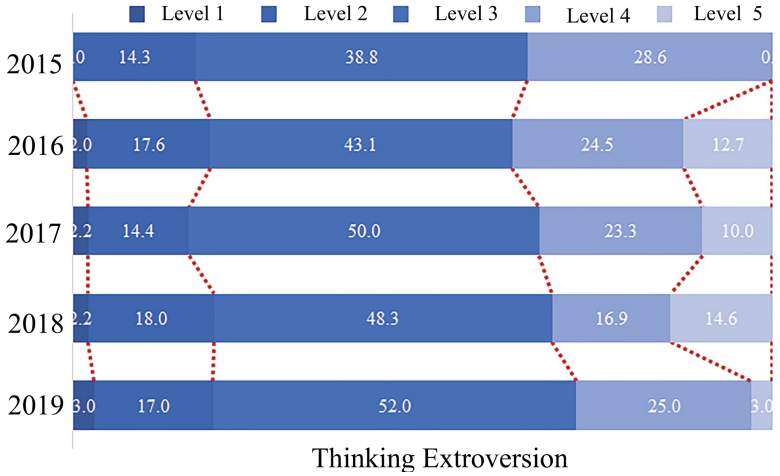

Fig. 4. Comparison of potion among levels of factor score from 2015 to 2019

Whether they success or unsuccess to obtain credits might be depended on the members who work with them in collaborative leaning class. It must be quite important for students. We have proposed the method of optimization, considering with factor scores in this time. We will have to examine closely, which teams or groups have been successfully or unsuccessfully.

5 Conclusion

We have investigated and examined how students' performance have been made up the transition from 2014 to 2019. The results have shown that most of their records have been improved, however, there remains some problems. The new prospective for optimizing collaborative learning environments has been proposed.

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Comparative Research on Terminology Databases in Europe and China

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Abstract. Terminology databases constitute an essential tool for academic research and practical translation. Both Europe and China have their special terminology databases for their actual need. The databases echo the integrated thought of Europe and China's terminology management mechanisms. The IATE in Europe is an inter-active database constructed over many years. China has already created a large set of terminology databases, e.g. TERMONLINE. The present study will comparatively introduce and interview both IATE and TERMONLINE, analyze the background of construction and provide real and practical information for translation. It can be concluded that with the advancement of emerging technologies in the future, more and more terminology databases will be designed and established in Europe and China, thus further keeping the balance between human and knowledge interaction.

Keywords: Terminology · Database · CNCTST · IATE · TERMONLINE

1 Introduction

The terminology management mechanism is a special system in which historical, political and commercial factors can affect the operation of that mechanism. The general management of terminology involves the use of resources and implementation of practices concerning the correct use of terminologies and their translation. Many scholars focus on the interactive translation or extraction system [1–8], on special definitions or semantic factors [9–14], on corpus or database [15, 16], or on cognitive effect [17], and theoretical construction [18, 19]. A multilingual community requires a more sophisticated language policy on the construction of database. The complexity of building up a terminology database shared by all members within the European Union (EU) countries is related to various factors. A basic factor in the management of linguistic and practical aspects of terminology is the diversity of languages and language families within the European Union, as well as historical and traditional parameters in the use and creation of terminologies. After many years of efforts, the EU creates its own database, the Inter-Active Terminology for Europe (IATE) database, for providing a web-based infrastructure for all EU terminology resources. IATE includes nearly all the existing terminology databases of the translation services in Europe, e.g. EurWORK database and EJN database etc.

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Government action to tackle the fundamental problems of terminology was called for by scholars and researchers especially when China opened up in 1978. The idea of building up a Chinese terminology database was considered in 1985 when the Chinese government set up a special organization, China National Committee for Terms in Sciences and Technologies (CNCTST), to examine, standardize and validate the terminology, and began to research on building the terminology database. TERMONLINE is a very important terminology database designed and built up by the CNCTST, and is available since 2016. More than 500,000 terminologies from different disciplines are involved in the database. The present study will discuss the construction and characteristics of both IATE and TERMONLINE, analyze the background of both databases, and provide real information for translation.

2 The IATE Terminology Database in Europe

The IATE is one of the most important terminology databases in Europe. Different member states share the terminology management mechanism within the EU. The description and presentation of terminology within countries of the European Union requires the standardization of terminologies, which may range from medical, scientific and technological domains, to legal and managerial domains. Availability and standardization of information are of crucial importance in the European Union. In the countries of the European Union, both national terminology databases and European Union terminology databases are available to translators, scholars, administrative staff, professionals in various fields, as well as the general public, depending on the type of database concerned. The EU considers IATE to be special and official database for managing terminology since the IATE includes almost, if not all, the official European Union languages, as shown in Table 1.

Table 1. Statistics for languages in the EU

Number	Languages	the Indo-European Language Family						the Uralic Language Family	the Semitic Language Family
		the Romance Languages	Greek	the Celtic Languages	the Germanic Languages	the Slavic Languages	the Baltic Languages		
1	French	+	-	-	-	-	-	-	-
2	Italian	+	-	-	-	-	-	-	-
3	Spanish	+	-	-	-	-	-	-	-
4	Portuguese	+	-	-	-	-	-	-	-
5	Romanian	+	-	-	-	-	-	-	-
6	Greek	-	+	-	-	-	-	-	-
7	Irish	-	-	+	-	-	-	-	-
8	English	-	-	-	+	-	-	-	-
9	German	-	-	-	+	-	-	-	-
10	Dutch	-	-	-	+	-	-	-	-
11	Danish	-	-	-	+	-	-	-	-
12	Swedish	-	-	-	+	-	-	-	-
13	Polish	-	-	-	-	+	-	-	-
14	Czech	-	-	-	-	+	-	-	-
15	Slovak	-	-	-	-	+	-	-	-
16	Croatian	-	-	-	-	+	-	-	-
17	Slovenian	-	-	-	-	+	-	-	-
18	Bulgarian	-	-	-	-	+	-	-	-
19	Latvian	-	-	-	-	-	+	-	-
20	Lithuanian	-	-	-	-	-	+	-	-
21	Finnish	-	-	-	-	-	-	+	-
22	Estonian	-	-	-	-	-	-	+	-
23	Hungarian	-	-	-	-	-	-	+	-
24	Maltese	-	-	-	-	-	-	-	+

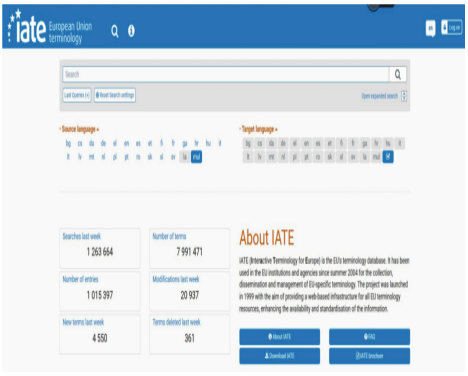

Fig. 1. Website of the IATE database

The IATE database provides a web-based infrastructure for all EU terminology resources. The website is administered by the Translation Centre for the Bodies of the European Union in Luxembourg on behalf of the project partners. Based on new technologies, the project of constructing the IATE started in 1999. The IATE, which includes nearly all the existing terminology databases of the EU's translation services, is now available to the general public since 2007. It is used for the collection, dissemination and the shared management of terminology related to affairs of the European Union. The IATE is a multilingual database. All languages shown in the interface in Fig. 1 are considered equal in the EU. The database covers both the Latin language and almost, if not all, the official EU languages as of today. Linguists and translators try to establish the equality among all languages and every terminology from source languages can be translated into different target languages.

The IATE database is also a live database. It is designed to be highly interactive and accessible and contains 8.4 million terms, including approximately 1.4 million multilingual entries, approximately 540000 abbreviations and 130000 phrases. Additionally, it may be noted that, based on official information, European Union terminologists, translators, administrators and other experts provide new terminologies every day. The contents of the database are under constant updating.

3 CNCTST and TERMONLINE Terminology Databases

Terminology management is a government action in China. A special organization was established by the Chinese government in order to serve terminology management in 1985. The CNCTST, China National Committee for Terms in Sciences and Technologies, aims to examine, standardize and validate the terminology all over the country. Under the management and leadership of CNCTST, China has already constructed a large set of terminology databases since the establishment of this Committee. TERMONLINE, constructed by the CNCTST, is an official internet knowledge service platform, providing terminology retrieval, management (error correction, collection, sharing), extraction, annotation, and proofreading services. TERMONLINE is considered a very important Chinese terminology database which includes more than 500000 standard terminologies, and covers more than 120 disciplines in general and fundamental ("basic") scientific terms, Engineering and Technology, Agricultural Science, Medicine, Human Culture, Social Sciences, Military Science and other fields. Table 2 indicates the years and number of terminologies established by the CNCTST.

From the information in Table 2 it can be concluded that the CNCTST began to validate the terminologies for more than thirty years. When a supportive infrastructure was nearly completed, CNCTST officially launched TERMONLINE on June 15, 2016. Terminology Online is a standardized terminology knowledge service platform. It is a "data center", "application center" and "service center" designed to support the development of science and technology and to promote international academic exchanges. It provides various services related to terminology. Detailed information is available on the website of TERMONLINE in Fig. 2.

TERMONLINE also provides interactive functions between system and users, including Error Correction, New Terminology Collection, Extraction, and Recommendation. The function of Error Correction is designed to present the opportunity for the public to correct or update the details of launched terminologies. It provides two blocks: launched terminology block and suggested block, including name, English translation, alias, possible name in Taiwanese Mandarin Chinese, definition, and discipline. As for the historical factors, Mainland China and China Taiwan have different expressions for the same terminology, and sometimes Taiwanese Mandarin Chinese expressions are familiar to many users, especially from ASEAN countries or from other foreign countries. Therefore, CNCTST considers possible names of terminologies in Taiwanese Mandarin Chinese to be an independent part in Error Correction.

Table 2. Years and number of terminologies

Years	Number	Years	Number	Years	Number	Years	Number
1988	1398	1996	21465	2004	5084	2012	29436
1989	3779	1997	14331	2005	15049	2013	34046
1990	1898	1998	15382	2006	7502	2014	36927
1991	1	1999	0	2007	9314	2015	5640
1992	1673	2000	6028	2008	37343	2016	35903
1993	23881	2001	0	2009	22834	2017	15294
1994	7761	2002	15691	2010	25449	2018	17503
1995	7412	2003	29850	2011	16077	2019	36394

Fig. 2. Website of TERMONLINE

The function of New Terminology Collection is created to collect potential new terminologies from the public. In particular, if a user has an idea for a term, the user can insert basic information for terminology, including name, English name, source, synonym, possible name in Taiwanese Mandarin Chinese, definition, discipline and a personal recommendation basis. Among the items, the first three ones are mandatory. Besides the basic information, users are suggested to submit their private information to help CNCTST contact them. The requested private information includes: name, institute, email and telephone number.

The function of Terminology Extraction and Annotation is created for the extraction and annotation of the terminologies from texts. For example, the system automatically returns three results from different disciplines for terminology of “Jiqi Fanyi (Machine Translation)” when there is an input of “Jiqi Fanyi Shi Henhaode Fazhan Fangxiang”, meaning “Machine Translation is a very good developmental direction”. The function helps users to find the launched terminologies in the database.

The function of Terminology Recommendation is constructed to recommend the related terminologies for readers based on the theory of semantic fields. For example, for the input of the term “Jiqi Fanyi (Machine Translation)”, the system provides different terminologies as a reference, including “example-based machine translation” “rule-based machine translation” “knowledge-based machine translation”, etc.

4 Comparative Research on Terminology Databases in Europe and China

The IATE is a multilingual and interactive database. The IATE is designed by the European Union (EU) to provide a web-based infrastructure for all EU terminology resources for sharing terminology information by the EU Members, targeting to its availability and standardization. In other words, the IATE database serves the collection, dissemination and management of EU-specific terminology. A basic factor in the management of linguistic and practical aspects of terminology is, in this case, the diversity of languages and language families within the European Union, where all languages are considered equal. This means that every term in the database has to be presented in all languages in the EU. Therefore, it can be considered that the IATE is a database supported by multilingual system. Furthermore, the IATE system has the function of dynamically accepting new terminologies from the users for the constant updating of the available information.

On the other hand, the TERMONLINE is a monolingual interactive database and created by a government-supported organization, the CNCTST. The CNCTST is created in 1985 to give advice and practical assistance to scholars, translators and researchers in China. It provides both Chinese terminology and its definition to take responsibility for examination, standardization, and validation of terminologies emerging from different disciplines in China. Since TERMONLINE is a database supported by monolingual system, no English translation of a definition is available even though the system gives English translation of entries for the purpose of disambiguation. Similarly to the IATE, TERMONLINE is also a live database; however, the system has different interfaces to collect suggestions about new terminologies, to extract terminologies from the input text, to correct error of terminologies in database, and even to construct a semantic field based on the input terminology.

5 Conclusion

The present research comparatively introduced both the IATE database in Europe and the TERMONLINE database in China. Both databases are constructed based on historical, political and commercial factors which can influence the terminology formation and variation. In general, both IATE and TERMONLINE are interactive systems allowing users to submit new terminologies. Both databases are supported by the government or by a government-related organization. The IATE is a multilingual system while the TERMONLINE is a monolingual system. With the advancement of emerging technologies in the future, more and more terminology databases will be designed and established in Europe and China, thus further preserving the balance between human interaction and availability of expert knowledge to a broader public.

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MOOC as an Innovative Tool for Design Teaching

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Abstract. The purpose of this work is to discover learning methods in the digital environment that facilitate the training of design students and show the teaching/learning possibilities offered by MOOCs for the education of this discipline. For this research, we analyze and explore how technological innovation can be introduced in the teaching of Design for the acquisition of knowledge in the context of higher education.

Keywords: Design education · MOOC · Interaction · Innovation

1 Introduction

With the emergence of ICT (information and communications technology) there were notable changes in the teaching and learning experience with several Internet-based services in favor of educational improvement. Sharing knowledge on a large scale was already possible, but with this technology the challenge increased to connect more people and make them more accessible.

To face this challenge, OERs (open educational resources) aim to provide free access learning materials. In Particular, MOOC (Massive Open Online Course) courses allow people around the world to have free online training, from any computer, mobile phone or electronic tablet, with no space or time limit.

We have identified in several design master's degree a problem facing students in their transition from undergraduate to postgraduate, specially in those students who came from background or study areas that differ from design training. Given this, there was also concern about what technological innovation tools design professors or their students, and face future challenges which over time become more digital. These concerns go along with possible teachers distress to leave aside their educational program or for unease with limited information on technological instruments. So, to dilute the situation we present an interface of a MOOC course of type XMOOC (Extended Massive Open Online Course), as a design project.

This project aims to demonstrate how MOOC serves as an online learning space to increase knowledge of those people who wish to specialize in design, whether they ultimately specialize or not. In addition, it aims to discover how to reduce a knowledge gap with which students apply for a postgraduate degree in design.

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We developed a practice based research approach, through a visual proposal and navigation system for a MOOC in interaction design. Our methodology is divided into three phases: exploratory, generative and evaluative. First, we have collected information through a review of the main literature to understand interaction design within higher education in Portugal and the use of MOOCs in university settings. These has led us to believe a MOOC course will function as an innovation tool where it is possible to experience new teaching-learning techniques to help students, mainly in Europe where state university education is characterized by being free and with minimal administrative payments, having MOOC courses will facilitate the entry of international students that will generate new income in favor of the institution [1].

This MOOC course contributes to obtain and perform innovative approaches in design education in Portugal, as it also develops an educational tool for higher education more in line with nowadays demands. MOOC also allows measurement and evaluation of the number of participants, their level of satisfaction with the subject and function as a space for suggestions on which topics are considered most suitable to level and deepen knowledge on design. They also allow each student to develop their own way of creating through active knowledge, matching online learning with classroom learning.

We believe that the teaching of design, through creation and innovation, can be committed to its economic, social and environmental environment, towards a responsible, supportive and sustainable development [2].

2 The Teaching of Design in University Higher Education

The background of the design discipline as a subject to be taught comes from the arts, initially it was not at a university level and therefore no academic degrees were granted, only certificates or diplomas were issued [3]. In Germany, the polytechnic centers were transformed into Universities of Applied Sciences, which led to the academy of design by having qualified craftsmen or specialized technicians put aside. As a result, academic standards for teachers were raised and anyone who wanted to teach needed a record of writing and publication, and an academic degree. The problem with this was that it was moving from design practice to academicism [3].

This thinking has evolved over time, “through the signing of the Bologna Declaration in May 1999, which dictates a whole revision of its education system. The Bologna Process is, for Higher Education Institutions, an opportunity not to be missed for the improvement of the quality and efficiency of education” [4].

At the same time it is presented as a challenge for the improvement of learning in design because “The condensation of basic design training into a shorter 1st cycle, the lightening of 2nd cycles, the absence of shared benchmarks for project teaching, or more generally on the duration and specific objectives of each cycle, seem to be some of the dominant concerns” [5].

3 Technological Innovation in Education

"In April 2009, the Lisbon Declaration was signed. In this agreement it was considered that both innovation and knowledge are the two most important factors today for the development of the people" [6].

One of the best ways to enhance these two factors is through the use of ICTs within the higher education space, a place that allows experimentation with new mechanisms for problem solving and where minds are trained to support the progress of society. A society not only focused on information but also on knowledge.

4 The MOOC (Massive Open Online Course)

According to the Oxford dictionary, MOOC defines it as: "a course of study made available over the Internet without charge to a very large number of people" [7]. They are also considered as: "Classes given through technological platforms that enable the teaching-learning process to thousands of students" [5].

The MOOCs emerged when in 2008 Dave Cormier coined the term to describe the course that George Siemens and Stephen Downes had created at the University of Manitoba. Shortly thereafter, in 2011, Sebastian Thrun and Peter Norvig created the first content MOOC, later to be called xMOOC, at Stanford University, reaching 160,000 participants [8]. Soon the different universities saw the potential of the MOOC to attract future students to their courses, and started to develop platforms to host these courses in open.

"The origin of the MOOC can be linked to two main phenomena: the rise of Open Educational Resources and the Open Social Learning" [9]. The model has its roots in the pedagogical theory of connectivism developed by George Siemens and Stephen Downes. According to Wade (2012), who has extensively explored this theory of learning - connectivism can be seen as a theory that provides guidelines for instructional development within an educational context because of the notion that learning is about building and connecting knowledge that is distributed in a network of connections [9].

4.1 Evolution of MOOCs

In January 2012 Thrun leaves Stanford to create the MOOC Udacity platform, in April Coursera is created and in May edX, a joint initiative of Harvard University and MIT (Massachusetts Institute of Technology) [8]. The first platforms for Latin American countries will appear in 2013.

The main types of MOOC courses are: xMOOC, cMOOC, SPOC, COOC, DOCC, NOOC, SPOOC, rMOOC, GROOC, and MicroMaster, the following table describes and shows its main characteristics (Table 1).

Table 1. Typology of the MOOC. Adapted from Castrillo et al. (2018, p. 40)

Initials	Description	Main feature
xMOOC	eXtended Massive Open Online Course	Massive open and with multiple offer and themes
cMOOC	Connectivist Massive Open Online Course	Interaction and collaborative work are the key elements
SPOC	Small Private Online Course	For a small and very defined group of participants
COOC	Corporate Open Online Course	Corporate for employee training
DOCC	Distributed Open Collaborative Course	Tutors distributed in nodes in different countries
NOOC	Nano Open Online Course	Small training pills of no more than 20 h
SPOOC	Self-Paced Open Online Course	You have no time limit to do it
rMOOC	Rhizomatic Massive Open OnLine Course	It is built from the participation of students around a theme
GROOC	Group Open Online Course	Groups that collaborate and work collaboratively to share their knowledge and experiences with others

4.2 The MOOC and Its Impact on University Higher Education

Probably the greatest challenges facing this system of open education are the following:

- The validation and certification of the participants' progress. Alternative forms of certification, such as pins, already exist, but it would be desirable to extend and generalise their use and acceptance.
- How to integrate the credits offered by MOOCs (if any) within formal education, at any educational stage.
- Achieving greater monitoring and tutoring of students. MOOCs represent a new pedagogical model that is much more horizontal than traditional online teaching.

The MOOC have been consolidated as a complementary formula to the traditional courses, and the future of the MOOC is becoming a reality, with more and more universities and Higher Education institutions offering MOOC with official credits associated to their completion, and it is expected that this will be the way of expansion, a closer integration and collaboration with official education, so that they truly represent a bridge to Higher Education [9].

5 Development of the Interactive Project

For the project, a web platform was designed under the name "Terminal de design", where the MOOC course is initially hosted. The name was born with the desire to position itself as a terminal or station where students are the travelers who come to the terminal (platform) with the intention of experiencing, exploring and discovering new ways and means of learning design, making use of technology.

The MOOC design course interface is of the xMOOC type (Extended Mass Open Online Course), where the "x" represents commercial MOOCs, that is, offered through commercial or semi-commercial platforms such as Coursera, edX and Udacity. These MOOCs emphasize traditional learning focused on watching videos and doing small test-type exercises. The course is developed around a regular teacher and a basic curriculum [9].

5.1 The MOOC Design Course

When entering the website the user has different options to enter the MOOC course, either by clicking on the "I want to register" button, the word "course" or "register". The idea is that people who enter the MOOC design course website can do so by different routes and in the shortest possible time, making it easier for them to navigate and trying to avoid leaving the site without registering.

Taking advantage of the pedagogical potential of the MOOCs, several internal pages were designed for the course, considering: Syllabus, lessons, study materials, forum, evaluation that will lead to a certificate, among others. All this content is supported by images, download resources, illustrations and videos that guide the student in each lesson (Figs. 1 and 2).

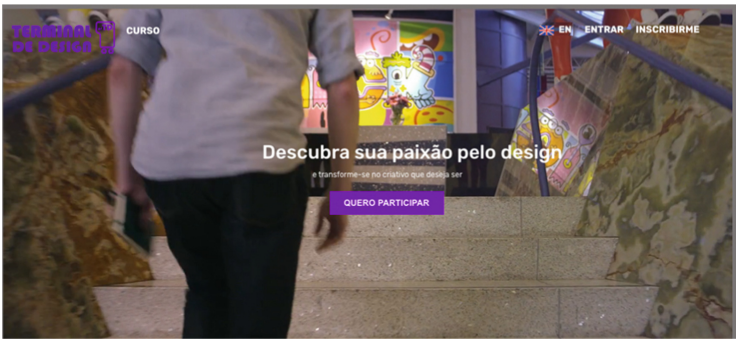

Fig. 1. Landing page of the Mooc course website. From Terminal de Design (2019).

Fig. 2. Screenshot of MOOC course interaction design. From Terminal de Design (2019).

5.2 Evaluation of the MOOC Design Course

As part of the learning validation of the students who take the MOOC course, the following actions are planned, which will help to identify the problems within the methodology developed for the course, such as: the realization of a design project, questionnaires of self-evaluation, peer evaluation tasks or P2P (peer-to-peer), among others.

In this initial phase to measure the level of interaction, satisfaction and positioning of the course in the virtual environment, Learning Analytics was chosen, a tool that allows to identify in a personalized way the learning needs of the students, helping them to overcome any difficulties they may have with the MOOC and avoiding the risk of dropping out of the course. The project will be perfected both in content levels and in interaction with the objective of leveling design knowledge and democratizing learning.

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Machine's Statistical Parsing and Human's Cognitive Preference for Garden Path Sentences

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Abstract. We focus in this article on the comparison between machine statistical parsing and human cognitive preference when dealing with the semantic circuit of garden path sentences. Stanford parser and 126 Chinese college students are introduced to discuss the parsing of garden path sentences. Machine has the ability to successfully parse sentences based on statistical information. If the statistical result is coincident with answer, an excellent parsing result comes into being. Otherwise, ambiguous effect and processing breakdown may occur. Human beings have their cognitive preference. When they are required to parse garden path sentences, some are confused by ambiguity just as machine does. However, some people, mostly belonging to high span readers with more linguistic experience, have special ability to disambiguate the sentences after backtracking and reanalyzing. We draw a conclusion that human beings sometimes parse some types of sentences better than machine does.

Keywords: Human factors · Machine parser · Computational linguistics · Garden path sentences · English learning

1 Introduction

A garden path sentence is a special one in which local ambiguity appears firstly and then is corrected automatically with the appearance of additional sentence components. Most readers sometimes interpret it in a wrong way because of its dead end or local ambiguity, which may result in a clearly unintended meaning during the processing. "False scent" [1], "processing breakdown" [2], "semantic circuit" [3], etc. are used to describe this phenomenon. "The horse raced past the barn fell" is a famous example of garden path sentence provided by Bever [4]. A word or phrase in a garden path sentence readers are familiar with always has more than one interpretation. Affected by the cognitive relative probability, readers believe the phrase will of course mean one thing it usually means. However, with the appearance of more components, readers find the fact that in reality the familiar meaning of the word or phrase means another meaning they are unfamiliar with, and they have to return to the ambiguous point to reanalyze. Semantic circuit

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pattern comes into being. Sometimes, readers are confused by the unfamiliar meaning and even they almost believe the sentence is misprinted, ungrammatical, or makes no sense. The phenomenon of breakdown during the process of understanding is called processing breakdown. When carefully read and fully understood, the sentence is parsed as a grammatically correct one after readers recover from the cognitive shock. Many scholars discuss the phenomenon from different perspectives, for example, eye-movement-supported research [5], second language learning [6–8], syntactic research [9, 10], early language learning [11], pragmatic research [12], cross-language research [13], cognitive research [14]. We will discuss the phenomenon from the perspective of machine's statistical parsing and human's cognitive preference.

2 Machine's Statistical Parsing and Human's Cognitive Preference

Readers in a region usually have their special cultural and cognitive preference. The way they interpret a word or phrase is not always a matter of personal preference. Sometimes, it is greatly affected by the reader group's speaking habit. Machine parser is sometimes based on statistical parsing and once the result is beyond the statistical scope, failure occurs. Human beings, native speakers or educated college students, have more advantages in understanding ambiguous English sentences than machine parser does, although they can also be disturbed by ambiguity.

2.1 Machine's Statistical Parsing Based on Stanford Parser

A special garden path sentence "The man lent the book never returned it" is introduced by Rayner etc. [15]. For example, "lent" is always described as $V_{\text{past tense}} \rightarrow \{\text{lent}\}$ in "The man lent the book (to sb)", while it is analyzed as $V_{\text{past participle}} \rightarrow \{\text{lent}\}$ especially after "was" in "The book was lent (to sb)" "The man was lent the book" "The man who was lent the book never returned it". However, without the help of "was", readers sometimes are confused by "lent" in "The man lent the book never returned it." Please see the parsed results from Stanford Parser for the sentences (http://nlp.stanford.edu:8080/parser/):

Example 1: The man lent the book.	Example 2: The book was lent.
Example 3: The man was lent the book.	Example 4: *The man lent the book never returned it.
Example 5: The man who was lent the book never returned it.	Example 6: The man given the book never returned it.

The parsing results are good except the result of Example 4 in Table 1. It is obvious that nearly all the items in Table 1 are unambiguous except "lent". According to the BNCweb (http://bncweb.lancs.ac.uk/), the probability of $V_{\text{past tense}} \rightarrow \{\text{lent}\}$ is 478 hits, and $V_{\text{past participle}} \rightarrow \{\text{lent}\}$ is 292 hits when the query "lent" returns hits in 548 different texts, sorted on node word with tag-restriction $V_{\text{past tense}}$ or $V_{\text{past participle}}$. Thus, a result of nonparametric statistics is achieved, i.e. $X^2_{(2)} = 172.85$, $p < .05$, which

means $V_{past\ tense} \rightarrow \{lent\}$ may be the most familiar answer among the choices of $V_{past\ tense}$, $V_{past\ participle}$ and the others. Once readers are required to interpret "lent", they prefer $V_{past\ tense}$ to $V_{past\ participle}$. Please see the nonparametric statistics result for "lent" in BNCweb in Table 2.

Table 1. Stanford parser results for sentences

Items	1	2	3	4	5
The	The/DT	The/DT	The/DT	The/DT	The/DT
man	man/NN		man/NN	man/NN	man/NN
book		book/NN			
who					who/WP
was		was/VBD	was/VBD		was/VBD
lent	lent/VBD	lent/VBN	lent/VBN	*lent/VBD	lent/VBN
the	the/DT		the/DT	the/DT	the/DT
book	book/NN		book/NN	book/NN	book/NN
never				never/RB	never/RB
returned				returned/VBD	returned/VBD
it				it/PRP	it/PRP

Table 2. Nonparametric statistics results for "lent" from BNC

Category	VBD	VBN	THE OTHERS
O	478	292	153
E	307.67	307.67	307.67
D	170.33	−15.67	−154.67
$(O - E)^2$	29012.31	245.55	23922.81
$(O - E)^2/E$	94.30	0.80	77.75
X^2	172.85		

Garden path effect originating from misunderstanding of "lent" is caused by false sense of description. According to results of corpus probability, "lent" is preferentially parsed as $V_{past\ tense}$, namely VBD. The machine's description from this result in Example 4 led to human's confusion and disorder, and readers felt puzzled at this result. "The book never returned it" is considered to be a SBAR (clause introduced by subordinating conjunction or 0, top level labeling apart from S, usually for complete structure). The machine's misparsing leads to wrong syntactic structure [16].

Please see the misparsing by machine in Table 3. The strange syntactic structure obviously brings an absurd meaning. According to the machine's misparsing in Table 3, parser shows unacceptable universal dependencies in Table 4.

Table 3. Syntactic structure caused by misparsing of "lent"

(ROOT
(S
(NP (DT The) (NN man))
(VP (VBD lent)
(SBAR
(S
(NP (DT the) (NN book))
(ADVP (RB never))
(VP (VBD returned)
(NP (PRP it))))))
(. .)))

Table 4. Universal dependencies caused by misparsing of "lent"

		root(ROOT-0, lent-3)					
		ccomp(lent-3, returned-7)					
				nsubj(returned-7, book-5)			
	nsubj(lent-3, man-2)				neg(returned-7, never-6)		
det(man-2, The-1)			det(book-5, The-4)			dobj(returned-7, it-8)	
The	man	lent	the	book	never	returned	it

According to root(ROOT-0, lent-3), the main structure is "[The man]NP + [lent the book never returned it]VP". The verb "lent" instead of "returned" is considered to be the main verb. The structure "[the book]NP + [never returned it]VP" is the outcome of system parsing, which doesn't come up to the normal logic thinking because [the book] NP has no function, according to Theta Theory, to work as a AGENT/ACTOR. Therefore, Example 4 is misparsed by system and brings no logical dependency relationship.

The word "lent" is ambiguous for machine parsing because it can be parsed as $V_{\text{past tense}} \rightarrow \{\text{lent}\}$ or $V_{\text{past participle}} \rightarrow \{\text{lent}\}$. Influenced by statistics-based cognitive preference, readers regard $V_{\text{past tense}} \rightarrow \{\text{lent}\}$ as the top choice, which seems to be in tune with machine's statistical parsing. However, if the cognitive preference proves itself to be wrong, garden path effect occurs, and readers have to give up most likely interpretation and start backtracking to choose the clearly unintended meaning. Human parsing is better than machine parsing because readers has the ability to act on their own initiative to deal with the processing breakdown. If the unambiguous "given" is used to replace "lent", machine parsing is excellent. According to the machine parsing in Table 5, we find the main structure is "[The man given the book]NP + [never returned it]VP", which is absolutely right because "given" is unambiguous for $V_{\text{past participle}} \rightarrow \{\text{given}\}$. Thus, system acts accordingly and brings the correct universal dependencies. Please see Table 6.

Table 5. Syntactic structure from machine's parsing of Example 6

(ROOT
(S
(NP
(NP (DT The) (NN man))
(VP (VBN given)
(NP (DT the) (NN book))))
(ADVP (RB never))
(VP (VBD returned)
(NP (PRP it)))
(. .)))

Table 6. Universal dependencies from machine's parsing of Example 6

						root(ROOT-0, returned-7)	
	nsubj(returned-7, man-2)						
	acl(man-2, given-3)						
		dobj(given-3, book-5)					
					neg(returned-7, never-6)		
det(man-2, The-1)			det(book-5, The-4)			dobj(returned-7, it-8)	
The	man	given	the	book	never	returned	it

The analysis above in Table 6 shows that Example 6 is an unambiguous sentence, and machine is good at parsing this kind of sentence.

2.2 Human's Cognitive Preference Analysis

To compare the parsing results between machine and human beings, we tested 126 Chinese college sophomores who come from Institute of English language and culture. For Example 4, the students provide different answers: negative 59; neutral 14; positive 53. According to statistical information, $X^2_{(2)} = 28.43$, $p < .05$. The test result means 57.93% of the students are confused by garden path effect while the others can understand the sentence successfully (Table 7).

Table 7. Statistical results for Chinese sophomores

Category	Negative	Neutral	Positive
O	59	14	53
E	42	42	42
D	17	-28	11
$(O-E)^2$	289	784	121
$(O-E)^2/E$	6.88	18.67	2.88
X^2	28.43		

We discussed with the tested students who provided the positive answer about the parsing, and most students said the ambiguity of "lent" is core of processing, and they went through a cognitive process of ups and downs. Please see the context free grammar and flowchart of processing in Fig. 1.

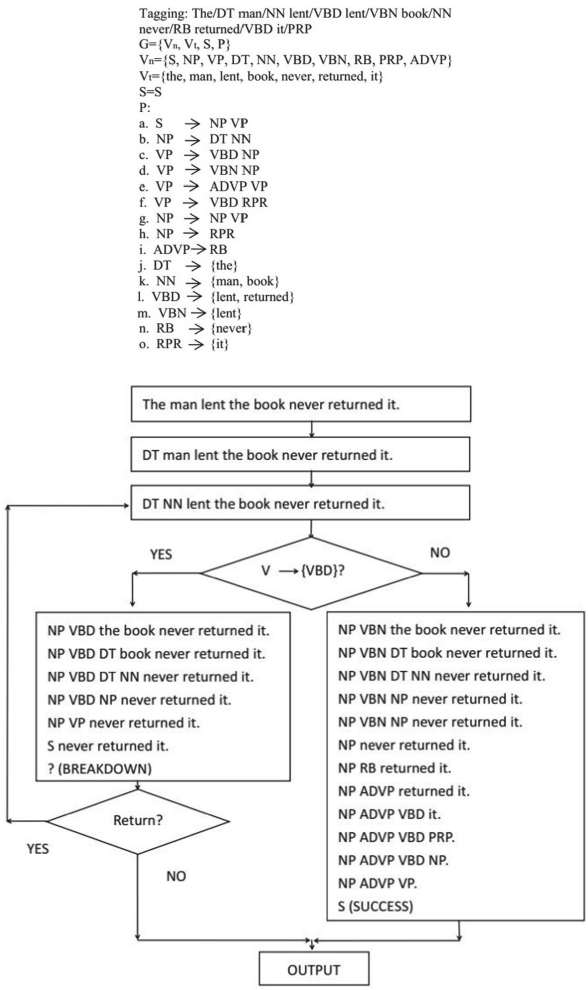

Fig. 1. The flowchart of cognitive processing of garden path sentence

With the help of syntactic, semantic and pragmatic knowledge, 42.07% of the 126 Chinese students, mostly belonging to high span decoders, recover from the cognitive shock and find the way out just like the flowchart of cognitive process in Fig. 1. They give up the cognitive preference of "lent" as $V_{\text{past tense}}$ to choose the non-preference of "lent" as $V_{\text{past participle.}}$ Just as Just and Carpenter discussed in 1992 [17], "the larger capacity of some individuals permits interaction among syntactic and pragmatic

information, so that their syntactic processes are not informationally encapsulated." That means high span readers can be more successful than are low span ones because they maybe read more and have more linguistic experience with the ambiguous types of sentences, and they are good at backtracking to the ambiguous point to reanalyze and at finding another successful way out.

3 Conclusion

A garden path sentence is a type of sentence with local ambiguity, which may bring processing breakdown for both machine parsing and human beings interpretation. By analyzing the parsing results from Stanford Parser and 126 Chinese college students, we find that both machine parser and 57.93% of educated learners are confused by the implied multiple interpretations. Affected by the ambiguity, machine parer shows unacceptable syntactic structure and universal dependencies. Just as machine does, 46.82% of students doubts the correctness of interpretation while 11.11% remains neutral. Only 42.07% of students with high span has the ability to hurdle processing barriers to succeed in decoding.

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Profiles of Professional Drivers Based on Drowsiness and Distraction Alerts

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Abstract. Driver inattention has been a major contributor to road crashes through the last years. Additionally, professional drivers are more expose to this risk due to the long work journey. The present study aims to explore the data collected by a commercial driver-monitoring system (DMS) in order to identify profiles of professional drivers. The DMS emitted an alert when distraction or drowsiness were detected, generating additional information such as timestamp, GPS and instant speed. The Hierarchical Clustering Approach and the K-means method were used to identify distinct profiles. The results showed a clear distinction among the clusters with respect to the exposition variables (time and distance related) as well as the number of inattention events.

Keywords: Road safety · Driver behaviour · Clustering analysis

1 Introduction

Driver distraction and drowsiness have received increased attention during recent years due to the rapid increase in vehicle automation technology that impact on the driver behaviour. These types of driver behaviour are associated to a degraded driving performance as well as to a significantly detrimental of the cognitive performance (e.g. reaction time) and therefore, to a negative impact on road safety [1–3]. Inattention, and particularly drowsiness/fatigue, has been widely studied with focus on professional drivers, considering that these drivers are more exposed to this type of risk behaviour due to the long work journeys. Most of the studies are naturalistic and driving simulator based-studies. However, these studies are both complex and costly to conduct being the sample frequently of small size. In this sense, the consideration of new data sources to this research field is of utmost interest. On the other hand, due to the potential consequences of driver inattention, driver-monitoring systems (DMS) have been developed [4] as aftermarket in-cab real-time systems and now shifting to the factory-fitted installation in new vehicles as an advanced driver assistance system.

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In this context, the present study explores the alert-based data gathered by a DMS in order to identify professional drivers' profiles both from the perspective of the trip and the alert by applying a clustering analysis.

2 DMS and Data Description

The DMS vendor is a facial biometric company operating in the automotive sector. The company developed a fixed dashboard infrared camera to obtain images of the face and eyes of drivers to detect drowsiness and distraction states and warning the driver for dangerous driving behaviour by emitting a sound alert. This solution was implemented in vehicles of 6 different companies.

The system at the beginning and the end of each driving activity (i.e. a trip) registers a timestamp and a global position system (GPS) position. During the activity, the system emits alerts to the driver, conforming to his/her responses, and registers a series of data related to the event, such as a timestamp, a GPS position, the instant speed of the vehicle and the type of the alert (drowsiness or distraction).

Note that the material used to conduct the present study was retrospective data extracted from the DMS vendor' database.

The collected data used in this study covers the period between December 2015 and September 2016. The original dataset was rearranged and treated according to the study objectives.

At the end, a total of 70 drivers, 1544 journeys and 21431 alerts were obtained.

In order to apply a clustering analysis, several measurements were created to be used as inputs. Basic measurements such as average journey speed, travelled distance and time (e.g. between origin and destination, or between alert locations) were calculated. Based on a map service, it was possible to identify four types of roads: (a) type 1: highway or high speed, (b) type 2: arterial roads, (c) type 3: tertiary roads or residential roads, (d) type 4: highway links. In addition, the alerts were grouped by the period of the day when they occurred, considering three periods – 6 am to 14 pm, 14 pm to 22 pm and 22 pm to 6 am.

In order to accomplish the drivers' profiles analysis from the perspective of the journey and the alert, two distinct datasets were created named journey-based and alert-based. In the case of journey-based dataset, each observation corresponds to a sub-journey defines as a continuous driving record. Note that a journey may have several sub-journeys if the driver stops during the journey. On the other hand, in the alert-based dataset, each observation corresponds to an alert of any type. Also, for each observation it was included the alert-accumulated effects in the view of revealing an event generation pattern.

Overall, the following variables were obtained:

- Average (Avg.) number of alerts per sub-journey
- Avg. distance between alerts per sub-journey
- Avg. breaking duration time (time between consecutive sub-journeys of the same journey) in [h]
- Avg. sub-journey distance in [Km]
- Avg. sub-journey speed in [Km/h]
- Avg. sub-journey time in [h]
- Avg. alert speed in [Km/h]
- Avg. journey distance in [Km]
- Avg. journey time in [h]
- Avg. number of alerts per journey
- Total travel time (total journeys) in [h]
- Total travelled distance (total journeys) in [Km]
- Avg. number of sub-journeys per journey
- Number (No.) of sub-journeys
- No. of journeys
- No. of alerts
- No. of alerts emitted on each road type
- No. of alerts emitted on each period of the day

3 Methodology

Data clustering techniques are algorithms that perform without predefined labels or categories for the data instances and therefore their objective of performing clustering is to suggest possible groupings of elements based on a certain similarity measure. In this study, we have used the Hierarchical Clustering Approach (HCA) [5] and the K-means (KM) method [6] as these techniques are among the most used in the literature.

Additionally, a validity index was applied to each KM clustering to define the ideal cluster configuration. The Silhouette Coefficient was chosen [7] to validate the clustering performance based on the pairwise difference of between and within-cluster distances. The optimal cluster number was determined by maximizing the value of this index.

4 Results

The application of the hierarchical approach suggested that the plausible number of significant clusters varied between 3 and 10. On the other hand, the Silhouette validity index suggested a clustering result with three clusters, with a Silhouette Coefficient (S.C.) of 0.358, and second-best configuration a clustering with five clusters with a S.C. of 0.33. Based on these results, we decided to analyse the clustering composition of $k = 3$ also because of the clarity of the groups' distinction and analysis. Therefore, three driver profiles were analysed.

In order to allow an easy and clearly analysis of the clustering results, we compared the median values of each variable of each cluster with the percentiles of their distributions for the entire drivers' dataset. Then, the values were grouped into four categories:

- Low (variable median in cluster less than variable median in the dataset);
- Moderate (variable median in cluster between variable median in the dataset and 75th percentile);
- High (variable median in cluster between the 75th and 95th percentiles of the variable in the dataset);
- Very high (variable median in cluster greater than the 95th percentile of the variable in the dataset).

Table 1 shows this variables' characterization.

Table 1. Professional drivers' profiles based on the median values (k = 3).

	Clusters		
	0	1	2
Number of drivers	28	23	19
Average alert distance per sub-journey	Low	Moderate	High
Average breaking duration time	Low	Low	High
Average sub-journey distance	Low	Low	Moderate
Average sub-journey time	Low	Moderate	Moderate
Average journey distance	Low	Low	High
Average journey time	Low	Low	High
Total travelled distance	Low	Low	High
Total travel time	Low	Low	High
Average sub-journey speed	Moderate	Low	High
Average alert speed	Low	Moderate	High
Sub-journeys per journey	Low	Low	High
Total journeys	Low	Low	High
Total sub-journeys	Low	Low	High
Total alerts events	Low	Moderate	High
Alerts 6am_14pm	Low	Low	High
Alerts 14pm_22pm	Low	Low	High
Alerts 22pm_6am	Low	Low	High
Average alerts per sub-journey	Low	Moderate	High
Average alerts per journey	Low	Moderate	High
Alerts on road type 1	Low	Low	High
Alerts on road type 2	Low	Moderate	High
Alerts on road type 3	Low	Moderate	High
Alerts on road type 4	Low	Low	High

Finally, a brief characterization of the groups is provided in Table 2 to a better understanding of the results.

Table 2. Synthesis of the clusters' characteristics for professional drivers (k = 3).

Cluster	Observations
0	28 drivers No raised alerts Low/moderate values of exposition parameters (14.92 km average travelled distance per sub-journey and 56.02 km/h average travel speed) 75% of the drivers from company 4, followed by 18% from company 6
1	23 drivers Moderate value of alerts (average of 20.31 alerts per sub-journey) Moderate values of exposition parameters (26.35 km average travelled distance per sub-journey and 44.28 km/h average travel speed) 78% of the drivers from company 4, followed by 17% from Company 3
2	19 drivers High number of alerts (average of 57.10 alerts per sub-journey corresponding to 0.32 alert/km) Highest values of exposition parameters (53.24 km average travelled distance per sub-journey and 69.91 km/h average travel speed) Highest mileage (total travelled distance of 3374.44 km and average journey distance of 163.8 km) Concentration of alerts on highways or high-speed roads (86% on road type one) 47% of the drivers from Company 3, followed by 21% from Company 1

Regarding the type of alerts grouped in Clusters 1 and 2, it was found that 94% and 53% are distraction alerts, respectively.

Indeed, it is possible to identify clearly three behaviour patterns in terms of exposition to the risk and driver inattention. Clusters 2 represents the profile with the highest risk and highest number of alerts. Cluster 1 is moderately exposed to the risk and moderate alerts occurrence and in contrast, Cluster 0 represents the lowest risk and lower number of alerts.

5 Discussion

As far as authors are concerned, this is the first study in the literature that aims to identify drivers' profiles based on alert events from retrospective driving data. Consequently, the findings cannot be directly compared to other studies' results. Yet, other studies that used real-world or simulator data were analysed and to some extent compared to present one.

The clustering analyses of the 70 professional drivers lead to three driver profiles distributed as follow: 40% of the drivers with no alerts were grouped together, showing moderate values, in average, that characterized the journey (e.g. time, distance, speed); 33% of the drivers with an average of 20.7 alerts per journey and low values, in averages, describing the journey; 27% of the drivers with an average of 135.2 alerts per journey and high values, in average, for the journey description.

Considering that despite the high number of variables used in the analysis, most of them are related to the journey description and only one (i.e. the speed) describes the driving performance, in our opinion, the division into three groups is effectively to identify profiles as low, moderate and high risky drivers. Based on this classification, we can analyse the distribution of the drivers' companies by clusters. For instance, drivers of company 4 are distributed in two clusters classified as low and moderate risk. In contrast, drivers of companies 1 and 5 are concentrated in cluster 2 classified as high risk.

Focusing on professional drivers, three main groups based on the total travel distance were also obtained and analysed by Figueredo et al. [8]. The authors used a telematics dataset from heavy goods vehicles to cluster drivers in terms of safety and economical driving. Subsequently to this first classification, a second one was applied on each group, again considering the travel distance as discriminant. It is worthy to mention that the data used by these authors comprehends more than 5,500,000 trips and 98,000 drivers, which is one of the studies with the highest number of observations using real-world data so far.

Also, Sekar et al. [9] explored the use of reliability engineering techniques such as z-scores and reliability demonstration charts to analyse driver behaviour. Driver behaviour was extracted from the data recorded by an in-vehicle monitoring system from 100 heavy-truck drivers over several years. The data included events such as over speeding, over revving, harsh acceleration, harsh braking and seat belt disconnects while driving. The techniques provided an easy and effective way for drivers and their managers to monitor driver risk profiles by classifying and identifying drivers with high risks. The authors found three clusters which were classified as high, moderate and low risk drivers.

These past studies have in common the selection of three clusters to classify drivers. Overall, and despite the number of clusters the present study allowed the identification of professional driver profiles with different levels of exposition to the risk of occurring safety-critical events either as a consequence of the alerts and journey characteristics.

6 Limitations and Conclusions

The present study explored, for the first time, retrospective data to investigate driver behaviour. However, this kind of data can be associated to several limitations, which may arise mainly from the use of retrospective data gathered under conditions not observed and controlled by the research team. At the same time, no other paraphernalia was used to collect information about roadway or driver as it is usually implemented in the naturalistic studies. These facts lead to the lack of relevant information such as journey schedule and purpose, including breakings, driver characteristics and real-time data (e.g. traffic volume and weather) that would allow to better interpret the study results. Additionally, and despite the effect of the journey was statistically controlled for, the vehicles may have been driven by different drivers across journeys. This concern was also reported in the study of Fitzharris et al. [2] which used a similar DMS as well as retrospective data. As stated by the authors, "this limitation can also be viewed as a strength as it represents a "natural experiment".

Despite the limitations, this study makes clear that this type of retrospective data has potential to be explored to road safety studies and its analysis should be seen as complementary to other studies using controlled methods of data collection.

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Shaping Digital Literacy in Knowledge Society

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Abstract. The paper argues that digital literacy includes the ability to search, select and process information in computer and network sources, content creation, and Internet safety skills. Educational approaches, training and learning methods which are parts of educational technologies geared towards shaping digital skills so important in the modern world. The article is based on the survey "Digital Media Literacy in the context of "Knowledge Society": state and challenges" KII-06-H25/4, team leader V. Milenkova. The main conclusions are that education and technological environment, are crucial in shaping digital skills and more efforts needed to improve the educational methods to create digital competences of learners.

Keywords: Digital skills · University education · New digital media and information literacy · Knowledge Society

1 Introduction

Developing competencies is largely related to improving young people's skills. They become the focus of European policies aimed at social prosperity and the well-being of citizens, as well as economic competitiveness. They related to the accelerated technological development, the prolonged period of active life, and the dynamics of social events. All this requires people to change their plans, adapt their skills, and follow the challenges of different transitions. Digital skills are an indicator for the development of society, the level of competence of the population, the readiness to accept new challenges in the context of social transformations.

In recent years, digital competence and skills have been of great interest in discussing what skills people need to have in the knowledge society [1, 3]. Deursen and van Dijk [2] present several guidelines regarding the field research.

2 Theoretical Consideration

Digital Literacy includes three groups of skills [4, 5]:

- Ability for informational guidance, control and management of information flows.
- Technical skills for working with technologies and abilities for understanding and adapting to the network logic of the environment;

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– A set of social skills as a prerequisite for building a socially acceptable style of behavior in the digital communication environment.

Digital literacy is a necessary abilities and skills to survive and work in the new digital environment [6]. Digital competence includes the confident and critical use of Information technologies for work, leisure and communication. It is supported by basic ICT skills: the use of computers to retrieve, evaluate, store, produce, present and share information, as well as to communicate and participate in online collaboration networks [7].

Internet users differ in their possession of: knowledge of how to get online, how to search for information and how to download information; knowledge of how the web works in order to navigate better; knowledge of the software, hardware, networks needed to resolve current problems or to provide updated versions of applications [7, 8]. Digital literacy is defined as skills, knowledge and attitudes to using digital media [9] as well as the ability to respond pragmatically to challenges and opportunities in a way that harnesses the potential of the Internet.

In this context, education is crucial and the role of the teacher in the constantly complicated situation is particularly important [11, 12].

Modern education stimulates the development of digital literacy; there is a series of examples in this direction that are indicative of the fact that digital technologies are entering and changing the existing methods of education and teaching in educational institutions.

Actions to implement digital technologies in education are adopted:

– investments in the purchase of digital equipment and the creation of laboratories and cabinets in schools and universities;
– creating computer programs for learning purposes;
– inclusion of information technology classes in schools' curricula;
– conducting projects and scientific forums on the issues of digitalization of education.

The main goal of educational technologies is to improve not only the learning process but also the efficiency of the education system. In the foundation of modern educational technologies is laid the integration of information and communication tools and achievements. What integrates digital technologies is enhanced interactivity, based on the concepts of *cooperative learning, collaborative learning, e-learning, for the achievement of digital literacy*. A basic feature of these processes and mobile learning as a whole is the desire to achieve a kind of an autonomy of the individual student/pupil. That is why the attention of specialists focuses on the theories of learning and their application in the teaching of various subjects.

The following approaches are implemented in education:

(1) *Learning in experience and through experience.* What characterizes the educational technologies in the foundation of which underlies learning through experience and in experience is the creation of life-related situations. In this type of learning problems which are close to the real life ones have an important place. Professionals talk about so-called authentic problems. Their solution allows them to create an educational environment in which the traditional roles of the teacher

and the pupils change. Pupils master the material as role-playing activities, where they improve their socio-cultural competencies (to fulfil certain social roles in a particular socio-cultural context). This type of learning offers opportunities to use preliminary knowledge.

(2) *Problem-based learning* is related to solving cognitive problems. In organizing it, the model of scientific knowledge follows, it is realized through the following stages:
   a. *Identifying the general subject* by the teacher, but it can also be formulated by the pupils. Its importance and relevance is important for the pupils involved in the research
   b. *Decomposing the general topic* of micro-topics and each group chooses their micro topic to work. This can be done through brainstorming and a through a conceptual network (the key words and logical links between them)
   c. *Planning and implementing* the research process.
   d. *Data collection* and preparation of a report on the activity carried out.
   e. *Presentation* of the development through a computer presentation.
   f. *Assessment* of the presentation of each group of the other participants. Criteria are discussed in advance are used, and they are accepted by all participants.

(3) *Global-oriented learning* is a conception based on inter-subject relations. The cross-border nature of cognitive activities carried out by pupils is a favorable prerequisite for improving their socio-cultural competences as well as the use of knowledge acquired on different subjects and aimed at achieving a higher level of education.

3 Methodology

The project aimed at studying digital literacy was the national survey *"Digital Media Literacy in the context of "Knowledge Society": state and challenges", №* КП–06-H25/4*, 2018,* funded by National Science Fund – Bulgaria, with team leader Valentina Milenkova.

The empirical data are obtained by qualitative methods: 4 focus groups and 15 in-depth interviews carried out with members of different social groups: students, young mothers, teachers, NGO agents.

Questionnaires (in both qualitative methods) were used to collect data on digital skills; they included questions regarding the frequency of use of Internet and social media as well as questions for self-assessment of knowledge and skills for working in a digital environment.

4 Results

We present the summarized results of the study. Digital literacy is directly related to digital skills, based on the availability of comprehensive general education. Digital literacy is continuously upgraded because it is a function of the development of digital

devices that are constantly entering into everyday life and professional structures. According to our respondents:

"Digital literacy:

- *refers to the ability of a person to find, evaluate and compile clear information through different digital platforms.*
- *requires cognitive skills (analyze, summarize, make research, etc.) and technical skills such as the ability to use a computer, internet, and mobile devices.*
- *Assessed by the quality and speed of creating text, images, audio and technology-based design.*
- *it does not replace traditional forms of literacy, but instead is based on traditional forms of literacy.*
- *It covers computer literacy, as most digital media technologies require a certain level of computer competence." - (D.I., IT Specialist).*

According to our respondents (following In-depth interviews), digitization has actively penetrated people's lives, both in the personal and professional and social spheres. It has become a very important part of the activities of institutions at different levels and in different fields. There are several posts. The digitization of society is expressed in:

"digitization and use of new technologies in all spheres of personal, social, political, cultural, scientific and other life. The digitization of society, however, is more - in fact, it expresses the degree of maturity, progressiveness and entrepreneurship of its individual members." – (N.V., PR in a state organization)
"Digitization presupposes and stimulates both free access to heterogeneous types of information and the free movement of the latter in the world." - (M.M. political expert).

The data show that business, public and non-governmental sectors use systematically various digital assets and services in their activities. This means that digitization is ubiquitous and global, it changes generations and their thinking, attitudes and qualities; it affects and reformats social structures and relationships, imposing them on digital technology requirements.

Here are some answers to the question: Does digitalization and digital literacy contribute to the development of society?

"Certainly because they require the formation of new types of abilities - skills to work with information and communication technologies, skills to use digital platforms and media for a variety of purposes and in a variety of contexts, search, verification and dissemination skills, skills to critically evaluate media content. The development of these abilities leads to a rethinking of education and citizenship - we talk about digital education and digital citizenship" - (GG, university lecturer).
"The technologies provide, on the one hand, an alternative and, on the other, modification, change and replacement of the traditional (without this technogenic factor) human activities, perceptions and opportunities." - (S.A., public sector expert).

Digitization of society is an indisputable fact and this is definitely a prerequisite for social development because it means providing new opportunities for the development of institutions as well as for forming new skills and qualities [10]. At the same time, there are communities that are hard to digitize, and this creates serious divisions in an age, ethnic, and educational aspect. Also often, the availability of digital literacy and skills can be combined with low general knowledge, insufficient social skills, which

means that these statuses need to be carefully considered and ways to deal with these divisions should be sought.

The development of digital literacy among young people depends to a large extent on the participation of education. At school, technology is present in abundance. Teachers assign homework that requires online research and online instruments, and they use software applications to manage these homework assignments. There are a number of examples in this direction which indicate that digital technologies are entering and changing the existing methods of training and teaching in educational institutions. But education is a conservative environment that affects not only the material conditions, but also the teachers themselves and their methods of work; which means that sometimes there may be a lag in the attitudes of teachers on the inclusion of innovative approaches and digital content acquisition, on the formation of digital skills and literacy in students.

Respondents share that the Bulgarian education is being digitized, but not always the digital devices which have been purchased are actively used and become the real basis for innovation in the educational process. More consistency, continuity and activity is needed for the real digitization of education and its grounding on successful practices and methods.

5 Discussion and Conclusions

Digitization is valued as an important process that has actively penetrated society by changing all areas of political, professional, social life and personal relationships and activities of people.

For the development of digital media literacy today, the role of the Internet is greatest. The mass distribution of speed and broadband Internet opens up additional opportunities that integrate modern mass communication with interpersonal communication and place them on those communication boards that deploy different processes of connectivity, actions and activities. "*Achieving greater effectiveness in training and acquiring knowledge involves the successful use of information and communication technologies, based on acquired skills for seeking and finding useful information and resources, as well as the capacity to analyze and combine the obtained information, to share and discuss different ideas and viewpoints, which they may comment on with their fellow students and teachers*" [12]. Digitization is a part of education, but there is still a sporadic and not yet purposeful and organized nature. More systematic action is needed, longer-term vision, more focused strategies on how to develop digital skills and literacy of individuals.

Bulgarian education is not always able to meet the new requirements and to take effective account of changes. "*Engaging young people in short-term or long-term courses could also contribute to their acquirement of important knowledge and qualities related to digital skills. One must not underestimate the conducting of seminars and lecture courses, the possibility of access to online tutorials, electronic textbooks and other means of enhancing digital competence; through these means, it is possible to develop extensive skills for seeking, identifying and critically assessing and using information, and for young people's more independent and creative behavior in*

a digital environment. For the formation of digital culture, it is of great importance to saturate the work environment with computers, and to include the Internet in the specific responsibilities of those performing different activities. The results showed that the working environment as well as age are identified as factors of digital literacy of people. In this sense, complicating the responsibilities, the work and the nature of the obligations becomes a prerequisite for the formation of digital literacy of the population" [12].

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Icon Design Recommendations for Central Consoles of Intelligent Vehicles

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Abstract. Advances in vehicle technology open up both opportunities and challenges for human-machine interface (HMI) design in intelligent vehicles. Design guidelines for icons in central consoles of vehicles have been discussed in human-computer interaction community, but more study and innovation are needed in icon design. In this paper, we investigated the displayed line thickness and size of icons in the intelligent vehicle's central control screen, based on international design guidelines and standards. The experiment involved 17 participants performing simulated in-vehicle secondary task. The result from the experiments shows that the usability of icons increases and the driver's workload decreases as the icons get larger. We also found a set of recommended values for size and line thickness of icons in this context. Future work will focus on providing design guidelines for other aspects of HMI design in intelligent vehicles.

Keywords: Human machine interface (HMI) · Icon design · Intelligent vehicle

1 Introduction

With the development and application of technology in mobile computing and internet of things (IoT) in vehicles, the automotive industry in China faces new challenges of designing innovative human-machine interfaces (HMIs) for the mass production of intelligent vehicles. One important aspect of HMI is about the interface design of the central console where drivers experience many different non-driving related tasks, which may lead to drivers' distraction while driving as well as high workload due to the increased amount of information displayed [1, 2]. Meanwhile, the central control screen is getting bigger and the in-vehicle infotainment provides more entertainment or life services. As a result, the design of icons on the central console, have been discussed in the current international standards, design guidelines [1–3]. A common concern of the standards and design guidelines for in-vehicle interface design is the size of icons.

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For example, the symbol size to ensure legibility is set to 12 mm for every meter of viewing distance [4] and the optimal visual angle of primary graphical elements are 86 arcminutes [5]. However, there are only a few studies about the displayed line thickness of icons. Through literature review, we find that when the line of sight is 700 mm, the line thickness of icons is greater than or equal to 0.35 mm [4]. Therefore, we want to deepen the research on the recommended values of icons' minimum size and explore more about line thickness.

With the development of new innovation in automotive HMI in China, many HMI products have already been in production in the Chinese market. We investigated 22 central console interfaces of intelligent vehicles at the Chinese market. We then summarized their information architectures, and the main features of icons, especially in terms of the size and line thickness. Following that, we invited six professional test drivers to subjectively score the central control screen interfaces and some vehicle's interfaces received high recognition in subjective evaluation. The minimum icon size of these interfaces is 6 mm, the average is about 18 mm and the most used value is about 13 mm. Based on investigation and literature review, we selected the reference range of the size (from 6 to 18 mm) and line thickness described by the proportion of line to icon size (from 5.88% to 17.64% of icon size) for the experiment.

We provided the participants with a relatively realistic driving environment by using driving simulators. The benefits of using simulators are to avoid unpredictable safety issues of participants and save resources. It is suggested that the more immersive driving environment, the more it facilitates the drivers to perceive themselves as more present in the (simulated) situation [6]. Thus, in this paper, an experiment is presented that will investigate the proposed conditions of displayed size and the line thickness of icons, in the intelligent vehicle's central control screen on a driving simulator.

2 Method

2.1 Participants

A total of 17 participants (11 male, 6 female) between the ages of 25 and 44 were recruited for this study (mean age = 33.35, SD = 5.97 years). All participants had at least two years' experience in driving, most of whom used central consoles frequently or occasionally while driving.

2.2 Experimental Environment

Because the location of the devices can affect the reading and operation of icons, we simulated the position of the driver and the central control screen of a real car based on the ergonomics in the automotive design process [7]. Regarding the seating position, the seat height was 260 mm, and the horizontal distance from the steering wheel to the accelerator heel point was 440 mm and the height of the steering wheel was set to 660 mm [7]. As for the position of the central control screen, we set the height from the center of the screen to the ground as 710 mm, the transverse distance between the center of the screen and the center of the steering wheel as 390 mm, and the horizontal

longitudinal distance as 150 mm [7]. At the same time, we tried to ensure that the eyes of participants were 710 mm away from the center of the central control screen. A tablet computer was used to simulate the central control screen and visualize the test content, which ran on a unity application designed to issue the commands like initiate a trial and to log data generated by the content. A experimenter is responsible for controlling the tablet computer. The daytime light (about 5 klx with a relative tolerance of 5%) was selected as the illumination condition in this test of vehicle visual display, as proposed by SAE J1757/1:2015 [8] (see Fig. 1).

Fig. 1. Test environment and test site.

2.3 Task

We used the classic research model of the in-vehicle secondary tasks. In this type of task, the primary driving task is to drive straight forward at a speed of about 30 km/h and the secondary task was to click the icon specified by the main test moderator on the central console under the premise of safety and stability.

Clicking tasks varied according to two independent variables: size of the icons (6 * 6 mm, 9 * 9 mm, 12 * 12 mm, 15 * 15 mm and 18 * 18 mm) and the line thickness of icons described by the proportion of line to icon size (5.88%, 11.78% and 17.64% of the icon size). Each participant performed all 15 tasks combined in levels of size and line thickness (5 levels of size * 3 levels of line thickness = 15 tasks).

The icon contents consist of the functions of navigation, music, camera and buying movie tickets (see Fig. 2). Icons were displayed in pure white (RGB: 255, 255, 255) against a background of at pure black (RGB: 0, 0, 0) in the center of a 12.3-in. screen with 16:9 ratio (see Fig. 2).

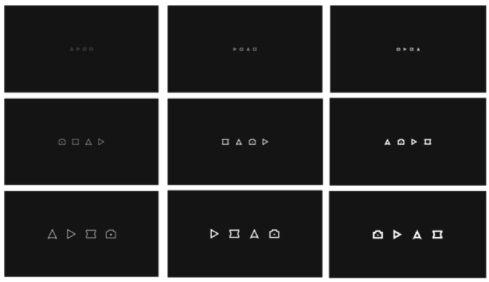

Fig. 2. Test contents.

2.4 Procedure

Participants completed a consent form and a questionnaire to collect demographic information. Next, the experimenter described the test purpose, test content and test tasks to them. They then received instruction on how to interact with the driving simulator, and completed several training trials to practice the secondary task. When the participants were familiar with the procedure, the formal experiment began.

In this experiment, participant received instructions for secondary tasks while driving smoothly at a speed about 30 km/h. After each task was completed, the participants were asked to fill out a questionnaire about usability and a single global workload rating [9]. Test contents were carried out in random order, but the tasks were released in a fixed order by the experimenter. The whole procedure lasted approximately 20 min.

2.5 Questionnaires and Data Analysis

In the experiment, we used a questionnaire about usability and a global workload rating questionnaire. Generally, usability is described in terms of efficiency, effectiveness and satisfaction. Because the experiment started from visual evaluation, we chose the clarity of the icon as the representative of efficiency and the understanding of the icon as the representative of effectiveness. We then designed a subjective questionnaire on clarity, understanding and satisfaction using Likert's 7-point scale ($\alpha = 0.870$), and we combined the average of the subjective scores of the three aspects to comprehensively describe the usability of the icons. As for the workload, we chose the global workload rating, the results of which were consistent with NASA-TLX's [9]. The global rating is a short form to rate how much workload was associated with each type of task using a 0 to 10 scale where 0 = very low workload and 10 = very high workload.

Since the data did not meet the normal distribution, the non-parametric tests were used, including the Kruskal-Wallis test [10]. All data were analyzed and visualized in SPSS and Excel.

3 Results

3.1 The Influence of Icon's Size on Usability and Workload

In the experiment, when the size of the icons is taken as an independent variable, the size of the icons has significant effect on usability ($p < 0.05$) (see in Table 1). As shown in Fig. 3, the usability of the icons increases as the icon gets larger. The average usability score of 9 mm icon size is 14.5% higher than that of the 6 mm icon size. In addition, the average usability score for the 12 mm icon size is 5.9% higher than that of 9 mm icon size. As a result, we can find that there are clear differences in usability score between the icon size of 6 mm, 9 mm, and 12 mm respectively. As the size of icons exceeds 12 mm, the usability growth trend slows down or even decreases. Thus, when the size of icons is larger than 12 mm, the size has little impact on the usability, and usability is greatly improved as it changes from 6 mm to 9 mm.

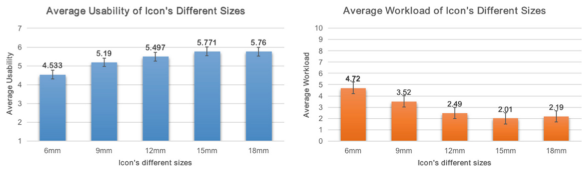

Fig. 3. Average usability and workload of icon's different sizes.

Table 1. Kruskal-Wallis test results of the icon size with clarity, understanding, satisfaction, usability and workload.

Dependent variable	Independent variable	Sig.
Clarity	Icon size	0.004
Understanding	Icon size	0.026
Satisfaction	Icon size	0.003
Usability	Icon size	0.000
Workload	Icon size	0.000

By calculation, we can see that the workload decreases as the size of icons grows ($p < 0.05$), which is contrary to the trend of usability values (see in Table 1 and Fig. 3). The average workload score of 9 mm icon size is 25.4% lower than that of the 6 mm icon size. In addition, the average workload score for the 12 mm icon size is 29.3% lower than that of 9 mm icon size. As a result, we can find that there are clear differences in workload score between the icon size of 6 mm, 9 mm, and 12 mm respectively. In other words, when the size changes from 12 mm to 15 mm, the driver's workload decreases with a more and more smooth trend (see in Fig. 3). Therefore, when the icon size is greater than 12 mm, the size of icons has little impact on the workload.

3.2 The Influence of Icon's Thickness on Usability and Workload

As for the test of the line thickness of icons, we still used usability and workload to describe the effect of different line thickness. Table 2 shows that there is no obvious trend in usability ($p > 0.05$) and workload ($p > 0.05$) as the line of icons becomes thicker. When the icon line is of medium thickness (11.78% of the icon size), the usability value is the highest and the workload is the lowest (see in Fig. 4). It can be seen icons with the lines of medium thickness perform better. But the different thickness of lines has no significant effect on usability or workload.

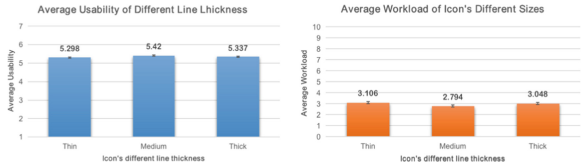

Fig. 4. Average usability and workload of icon's different sizes.

Table 2. Kruskal-Wallis test results of the icons' line thickness with clarity, understanding, satisfaction, usability and workload.

Dependent variable	Independent variable	Sig.
Clarity	Icon's line thickness	0.933
Understanding	Icon's line thickness	0.762
Satisfaction	Icon's line thickness	0.537
Usability	Icon's line thickness	0.813
Workload	Icon's line thickness	0.588

4 Conclusion and Discussion

In this study, we present an experiment to test the different displayed size and line thickness of icons in the intelligent vehicle's central control screen on a driving simulator. Results show that the minimum size of icons should be 9 mm and the icon size between 12 mm and 18 mm is recommended in central console interface design. Although the difference between the different line thickness was not significant, the medium thickness of line (11.78% of the icon size) is the recommended. We need more studies that investigate the line thickness in combination with icon size in order to detect certain patterns.

In addition, because this experiment is carried out under a 12.3-in. screen with 16:9 ratio, more consideration is required when using experimental results on other screens of different sizes and proportions. However, this experiment proposes a basic research method from the perspective of visual design and workload for the in-vehicle equipment in a dynamic environment. And it can be further utilized to detect optimal design patterns using a larger data-set.

5 Future Work

Starting from the icons, we can further study the dimensions of fonts, colors and layouts in the central console interface design in the future. The proposed design guidelines for the intelligent vehicle's central console can provide a theoretical basis for the current innovative design wave of global automotive human-machine interface. It can also improve the driver's information processing for driving tasks and in-vehicle secondary tasks, and expand on the current knowledge of user-centered design.

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Augmented, Virtual and Mixed Reality Simulation

Personage VR – A Virtual Reality Story-Telling Tool to Raise Awareness About Ageism

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Abstract. The PersonAge VR project has the two-folded goal of using Virtual Reality (VR) and interactive storytelling to divulge the research and knowledge in the field of ageism and, in the process, to raise awareness about ageism in the population. The system we conceived and developed allows experiencing ageism under three different points of view: the victim, the perpetrator, and the witness. We performed preliminary usability tests (formative usability) with 8 participants from the point of view of the victim. The system was found to be easy to use and the participants provided feedback about the emotions felt when playing the role of an elderly person. The participants felt strong anger and surprise. These feelings could be associated with a situation of discrimination.

Keywords: Virtual Reality · Ageism · Interactive storytelling · Usability

1 Introduction and Related Works

The term ageism has been introduced for the first time in the domain of gerontology by Butler in 1969 [1]. It defines the discrimination of one age group by another age group. Although this definition suggests that any age group can be victim of age-related discrimination, several studies have shown that elderly people are among the most discriminated [2]. Thus, in the scientific literature, the term of ageism is generally used to indicate the discrimination against the elderly.

In comparison to racism and sexism, research on ageism has been neglected until now and our knowledge on the issue remains limited. However, this phenomenon is unfortunately pervasive in our society and oftentimes disregarded. In 2008, the European Social Survey involving 28 European countries showed that ageism was more frequent than sexism and racism in both the general population and the elderly [2]. Ageism can be experienced in different life domains (e.g., health care, social services, leisure, family, and public services) and it can be blatant (e.g., insults, maltreatment, physical abuse) or subtle (e.g., lacking respect, being ignored or patronized). Thus, independent of the domain and form, ageism has a negative impact on an individual's health, well-being, and the ability to make the most of one's life

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opportunities [3, 4]. Consequently, it is essential that the fight against ageism is met with both legal action and training for future and current professionals working with the elderly. At the same time, it is fundamental to raise awareness of age-related discrimination in the general population and among different age groups.

VR has been successfully used in the past to raise awareness about topics such as sexism [5], cyberbullying [6], etc. In the field of ageism, it has been shown that negative stereotypes on seniors have significantly diminished when people have been assigned to avatars of seniors in an immersive virtual environment [7]. Additionally, researchers have shown how VR can be used to reduce ageism when people are exposed to "indirect" threats (e.g., reading an article about how the growth of older people is a threat to younger people). On the contrary, VR-based experiences resulted less effective when participants were exposed to "direct" threats (e.g., older people explicitly saying that they don't like the younger generations) [8].

Considering the existing studies, we believe that VR could be used in an innovative way to disseminate and raise awareness about ageism.

This paper is structured as follows: Sect. 2 presents the scenario and the tool that we developed; Sect. 3 presents the methodology that we used for the preliminary test. Section 4 reports the results; Sect. 5 concludes the paper and presents the future perspectives.

2 Scenario and Simulator

The "PersonAge VR" application has been developed by a team of researchers in human-computer interaction and social sciences. The scenario simulated by the application is based on real experiences collected during previous studies conducted by the team.

The application allows experiencing ageism under different points of view (PoVs). It focuses on the dialogue between an elderly person (the victim) trying to buy a new smartphone from a vendor (the perpetrator) with the help of his son/daughter (the witness). The three roles permit to explore different aspects related to ageism. In this paper, we focus on senior's PoV.

The scenario is composed of two scenes. The first scene is shorter and it has an introductory role. It allows the user to get used to the VR environment while getting aware of the situation and the relationship between the characters. In this scene, through dialogues, the user will learn the character's objective: the senior has to buy a new smartphone; the daughter/son has to support her/his father; the vendor has to sell the smartphone. In addition, this first scene helps the user to get an understanding about the age of the played character. For instance, when interpreting the senior's PoV, a mirror strategically placed in the room reiterates the age difference between the characters (see Fig. 1).

Fig. 1. The elderly looking at his son and seeing himself in a mirror during the introductory scene.

The second scene is where the main action takes place: while the senior tries to get a new smartphone, the vendor takes on a discriminatory attitude by interacting mostly with the daughter/son and progressively excluding the senior from the conversation.

From the point of view of the interaction, the user can interact with the story by simply choosing one between two options. The options are shown in two circles beside the character that is asking a question or waiting for an input from the user (see Fig. 2). When the answer is selected, the system provides a short feedback and then the dialogue continues, reacting to the user's choice.

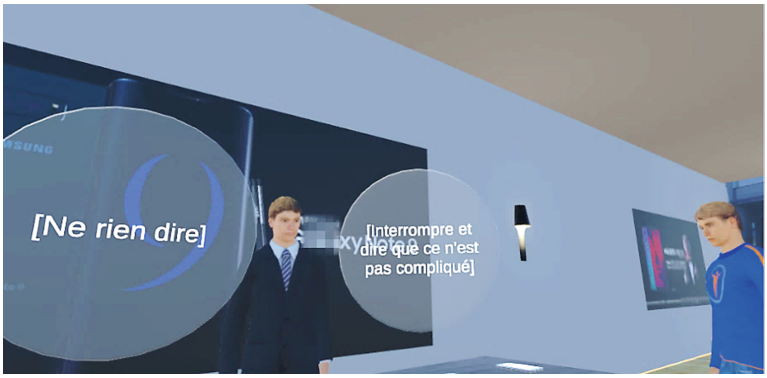

Fig. 2. The shop scene. The two circles beside the vendor (with a black suit) show the possible options (left: "Choose to not say anything"; right: "Choose to interrupt the dialogue and argue that it is not complicated").

In this first prototype of the system, we chose to use only textual dialogue (no voice). For this reason, to attribute a dialogue to a given character, the text is shown near the character concerned by the action. If the dialog is outside of the user's field of view, an icon indicates the direction to check to read the ongoing discussion.

In order to select the left or right answer, the user has to click a button on the left or on the right controller, respectively. To avoid showing a wall of text, hard to read, the options proposed to the user describes in a few words the intent of the response. The full answer provided by the user is then shown on the bottom of the screen.

The controllers are also used to bring into the VR the position and orientation of the user's hands. This is done by tracking both controllers and using inverse kinematics. From the position/orientation of the hands and the position/orientation of the user's head (achieved by tracking the headset), the system is able to approximately reconstruct in VR the posture of the user.

Finally, in order to customize the experience and make it more immersive, the three VR characters can be customized to better fit the user in terms of gender and size.

The system has been developed using Unity [9], with characters being created using the MakeHuman tool [10], and animations being added to the characters using Mixamo [11]. In order to make the participant feel more immersed, we used Final IK [12] for Unity. This solution uses inverse kinematic (as explained above) to animate the avatar played by the user. The dialogues are managed through the VIDE Dialogues [13].

3 Methodology

The pre-tests, conducted with 8 people (ages 23–35 years old, 2 women) followed a quite simple test protocol. In the first introductory phase, we explained the structure of the experiment, the data that we will collect, and we provided general information to the use of VR. We explained the goal of the character that the user will play (i.e., buy a new smartphone). Finally, the user signed the consent agreement and the experiment started.

During the experiment, we used the think-aloud protocol [14] to detect usability problems. We recorded the audio and an observer took note of relevant events. If needed, the observer encouraged the participants to commit to the think-aloud protocol. In order to avoid considering other forms of discrimination (such as sexism), during this test, we always used a male character (the son) for the role of the witness and the senior avatar always matched the gender of the participant.

After the experience, we provided an ad-hoc questionnaire to investigate whether the player understood the age of the characters involved and we investigated their emotions during the dialogs.

In particular, the questionnaire was composed of 4 sections: in the first section, we collected general information about the participants such as the age, gender and whether they had or not previous experiences with VR. In the second part, we collected additional feedback about the usability of the system. We investigated particular aspects of the interface such as the readability and comprehension of the text and whether the proposed method to select an answer was easy to use. We also investigated whether the graphical representation and the context (e.g., the dialogs) provided enough information to make understandable the age of the virtual avatars. In the third part, we investigated the emotion felt during the experiment by the participants playing the role of the senior. We also asked about the emotions that the other characters may have felt. In particular, we asked to provide a score between 0 and 5 to each of the

6 basic emotions: Happiness, Sadness, Surprise, Fear, Disgust, and Anger. Finally, in the fourth and last section of the questionnaire, we asked about previous experiences related to ageism.

4 Results

From the point of view of usability, the system was found to be easy to use. Everyone was able to complete the scenario by selecting the desired answers. The think-aloud protocol permitted to detect and correct some usability problems. In particular, the way we used to show the dialogs coming from the user's avatar itself was perceived as not very intuitive from many users.

All the participants were able to correctly guess the age of the VR characters. The great majority of participants estimated that the senior is 65 years old or more, and that the other two characters are between 20 and 45 years old.

Figure 3 shows the emotions felt by the user during the test (the character of the senior) or the emotion attributed to the characters of the vendor and the character of the son.

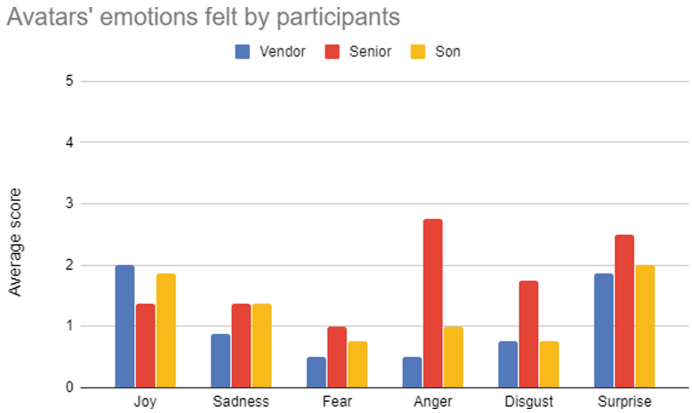

Fig. 3. The average evaluation score of felt by the participants on the six basic emotions. Scores span from 0 = "none" to 5 = "very strong". The "senior" score is related to what they felt during the test; the other scores represent the emotion attributed to the other characters.

The results show that the scenario was able to make feel strong negative emotions (anger, surprise and disgust) as the participant was victim of discrimination. The participants attributed to the vendor emotions related to joy and surprise. The joy could be explained by the fact that the vendor was able to sell the phone. The surprise was related to the fact that they did not expect the elderly customer was able to use the

advanced features of the smartphone (e.g., digital album). The participants attributed to the son character a strong feeling of surprise, probably motivated by the vendor's behavior.

Finally, when questioned about previous experience with ageism, 5 out of 8 participants said that they have been treated unfairly because of their age. However, that was something that happened rarely or sporadically. One participant reported one situation of discrimination but that was related to her gender.

5 Conclusion and Perspectives

In this paper, we presented a VR-based tool that aims to use immersive and interactive storytelling to raise awareness about ageism. The preliminary tests suggested that the system was easy to use and able to transmit strong emotions related to a discrimination scenario. The next step will be to test all the PoVs (victim, perpetrator and witness) on a bigger sample and to measure and compare the impact of our system on the awareness of ageism. In addition, the different PoVs will allow considering different aspects that may have an impact on an ageist behavior (time pressure, family or social relations, etc.).

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Evaluating Visual Perception by Tracking Eye Movement in Architectural Space During Virtual Reality Experiences

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Abstract. This study quantitatively evaluated subjects' visual perceptions and experiences of an architectural environment in virtual reality. This study was conducted to empirically determine which spatial elements subjects were most interested in in virtual architectural space; to analyze the sequence of objects that captured subjects' visual attention, how long each object captured their attention for, and the number of objects in each area of interest that captured their attention; to analyze subjects' emotional responses to virtual architectural spaces. A head-mounted display with an integrated eye-tracking device was used to measure the visual attention that subjects paid to spatial elements of a virtual environment. The result showed which architectural and interior elements subjects paid the most attention to in an area of interest in the virtual architectural space. This study's findings provide useful information and practical guidelines to architects and designers about which built environment elements attract occupants' visual attention and what types of physiological responses the elements cause. The conclusions drawn from evaluating visual perception with state-of-the-art VR integrated eye-tracking technology can inform architectural design processes to improve user experiences.

Keywords: Virtual reality · Head-Mounted display · Eye tracking · Architectural space · Visual perception · Evaluation

1 Introduction

This Architectural design should account for users' interests and visual perceptions, not just be a product of an architect's or designer's intuition. However, there are fewer ways to assess usability and users' visual perceptions of architectural designs through the use of 3D prototypes than graphic and product designs. Virtual reality ("VR") technology has a significant potential to solve this problem by creating immersive experiences of architectural spaces. State-of-art VR technology has increasingly been used in architecture and interior design research, but there has been little research on user experience and visual perception in built environments using VR.

Spatial analysis of VR environments has a significant potential for use in the field of architecture, but it is still in its infancy. Its use can be improved by studying how users visually perceive architectural spaces in VR. Eye-tracking technology has been

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integrated in head-mounted display ("HMD"). However, little research using the cutting-edge VR systems has been conducted. The latest HMD-integrated eye-tracking devices allow for comprehensive analysis of users' attention, the sequence in which they examine spatial elements, their visual scan paths, and their behaviors. Eye-tracking has been used to assess marketing stimuli, such as packaging or point-of-purchase marketing [4]. However, there has not been much research evaluating the visual attention paid to VR architectural space [8].

This paper describes a novel quantitative method that tracks users' eye movements to understand how they experience virtual spaces. User experiences happen in real-time as a result of users' senses and perceptions, so there are limitations to describing these experiences linguistically. Therefore, there is a need for a way to measure user experiences of architectural spaces and ways to measure non-verbal human cognition, sensation, and behavior in real time, such as neuromarketing. In this study, a neurocognition methodology was used to evaluate architectural spaces by tracking users' eye movements.

This study was conducted to quantitatively assess users' visual perceptions and experiences of a virtual architectural environment. This study was conducted to understand which spatial elements of a virtual architectural space users are most interested in; to analyze the order in which they view spatial elements, how long they pay attention to them, and the number of spatial elements that users pay attention to in an area of interest; and to analyze users' emotional responses to spatial elements. A head-mounted display with an integrated eye-tracking device was used to measure visual attention. The study included both an experiment and a survey. The former measured subjects' eye movements and the latter measured their emotional responses during the experiment. This study can provide insights to architects and designers for establishing an evidence-based design strategy.

2 Methods and Materials

This study was conducted in two phases: an experiment and a survey. The experimental protocol was reviewed and approved by the Yonsei University Institutional Review Board for the protection of human subjects. The experiment was conducted using HMD based eye-tracking. Subjects were surveyed after the experiment.

2.1 Experimental Stimuli and Procedures

The experimental stimulus was the 360° virtual representation of a real architectural space. The space was modeled using a 'Thera V' 360° camera by Japanese manufacturer Richo, which can record 360° images and high-resolution video. It is also capable of processing images by precisely stitching them together. The final selected images were modified using Adobe Photoshop CS6 for experimental stimuli purpose. Three types of 360° images of architectural space were developed from different perspectives. They were reviewed by five experts and professionals in the architecture field and one was selected as the experiment stimulus. The selected image was the main lobby of commercial building located in Seoul, Republic of Korea. The architectural

space included areas of interest ("AOI") containing the following spatial elements such as architectural components and interior objects: floor, wall, ceiling, staircase, furniture, lighting fixture, and display object.

2.2 Participants

The Six participants in their 20s participated in this study. All trials were conducted during a working day at the university lab in October 2019. None of the participants had visited the building used as the experimental stimulus. Six subjects participated in this study because of common practice in eye-tracking studies [11]. Nielson found that usability tests produce the best results when they are conducted with no more than five participants and that as many small such tests as can be afforded should be conducted [6].

In order to produce valid results, only data with a tracking ratio of more than 90% were collected. Data from participants who suffered from severe dizziness during the experiment was excluded. One of the participants failed to properly calibrate their eye-tracking software so no eye-tracking data was produced for them. Data from a total of five participants, three of whom were male and two of whom were female, was included in the final data analysis. These participants were all undergraduate students in their 20s. All participants stated that they had experience using VR systems.

2.3 Measurements

Eye-tracking data was analyzed in order to quantitatively measure participants' visual attention. Attention maps were produced which visualized eye-tracking data in the form of a heat map [2]. Attention maps are helpful to summarize large amounts of eye-tracking data and describe its overall spatial distribution. In addition to attention data, scan paths were analyzed in order to trace participants' eye movements over space and time. Measurements, such as fixation count, fixation duration, coordinate, gaze path, and gaze pursuit, were taken from raw eye-tracking data to characterize participants' visual perceptions.

In this study, researchers defined and classified the main spatial design elements as AOIs. AOIs are regions of the image that researchers defined and classified by shape and about which quantitative measurements can be made [1]. AOI events connect the data to the stimulus space and key performance indicators. In this study, AOIs were defined for each still image according to the spatial elements in it. The three metrics used to analyze participants' visual attention for AOIs were fixation sequence, total fixation duration, and fixation count. AOI sequence of fixation was measured first. Fixations sequences were based on both spatial and temporal participant eye-tracking data [1, 2]. Second, total fixation time, defined as gaze duration, was measured for each AOI. Total fixation time was the amount of time that participants spent looking at a particular AOI. Attraction was defined as the combination of total fixation duration and fixation count [10]. Third, fixation counts were calculated each AOI. Fixation refers to the elements or AOIs where information collection and processing occurred [7]. Fixation count is a measure of importance [5].

In addition to quantitatively tracking participants' eye movements, participants were asked to complete a survey after the experiment to measure their emotional responses to the virtual space. The survey questionnaire items were adapted from those used in previous studies [3, 9]. Participants were asked to answer for their emotional responses to the virtual space on a five-point semantic differential scale, a standard scaling technique used in social and behavioral sciences. It is most frequently used in psychology, but it is also used in sociology, marketing, and other empirically oriented disciplines [9]. In this study participants were asked for how much each of 13 pairs of adjectives described their responses: traditional-modern, complicated-simple, static-dynamic, planar-three-dimensional, unfashionable-sophisticated, obvious-ambiguous, discontinuous-continuous, solid-fluid, unchangeable-flexible, symmetrical-asymmetrical, non-repetitive-repetitive, cheap-luxurious, unchangeable-changeable. All participants' responses were collected via an online survey. The data was analyzed statistical software JAMOVI (1.0).

3 Analysis

This study analyzed visual attention by tracking participants' eye movements. Figure 1 shows the participants' average attention maps: a heatmap and a gridded dwell map. The gridded dwell map was divided into a set of 16 × 16 rectangular cells and numerical values were converted into colors and intensities. Numbers in grid cells are total dwell time values [2].

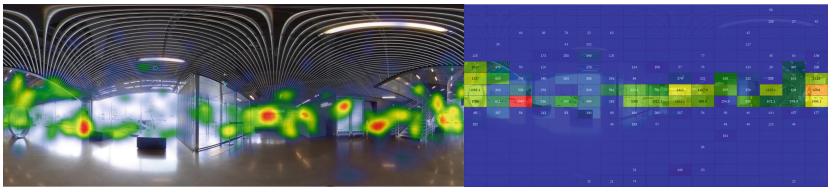

Fig. 1. Heatmap (*left*) and Gridded dwell map (*right*)

The metrics were used analyze participants' visual attention paid to AOIs: sequence of fixation, total fixation time, and fixation count. The elements of AOIs were floor, ceiling, lighting fixtures, entrance doors, staircases, furniture, and display object. Table 1 shows Key Performance Indicator ("KPI") data of AOIs.

First, the combined fixation sequence of all participants for architectural space was analyzed as shown Fig. 2. The AOI fixation sequence was the wall, light fixture 2, floor, ceiling, furniture 3, furniture 1, staircase, display object, furniture 2, lighting fixture 1. This result shows that participants paid a significant amount of attention to the wall with glass door at entrance but little attention to lighting fixture 1. Second, the combined total fixation time of all participants will be shown on architectural space. The total fixation time analysis shows that participants looked at the wall with entrance door for the longest on average (4027.1 ms) and lighting fixture 1 for the shortest on

Table 1. KPI data analysis of AOIs

AOI	Sequence of fixation	Total fixation time (ms)	Average fixation (ms)	Fixation count
Floor	3	5942.2	271.7	20.3
Wall	1	4027.1	280.9	13.3
Ceiling	4	5090.8	270.9	17.5
Staircase	7	3162.0	266.2	10.5
Lighting fixture 1	10	64.0	64.0	10
Lighting fixture 2	2	138.0	39.3	0.8
Furniture 1	6	377.0	118.3	1.5
Furniture 2	9	266.0	143.0	1.3
Furniture 3	5	93.0	93.0	0.5
Display object	8	1709.0	290.5	5.5

average (64.0 ms). Third, objects' combined total fixation count for all participants was, from highest to lowest: floor, ceiling, wall, staircase, display object, furniture 1, furniture 2, lighting fixture 2, furniture 3, lighting fixture 1. The overall results show that spatial elements captured subjects' visual attentions are mostly architectural components than interior objects. Lastly, as the result of emotional responses, a paired t-test analysis showed that the subjects thought of the space mostly as, from highest to lowest: modern, dynamic, fluid, flexible, luxurious, sophisticated, three-dimensional, changeable, unsymmetrical, continuous, repetitive, simple, ambiguity.

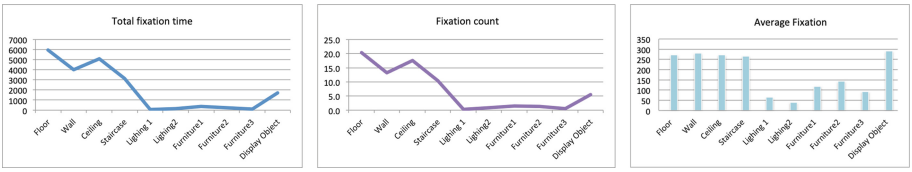

Fig. 2. Total fixation time (*left*), fixation count (*middle*), average fixation (*right*)

4 Discussion and Conclusion

This study used a new VR based method for analyzing visual perception of and emotional responses to spatial design elements. The results of this study have practical implications for architects' and designers' design processes. The technique tested in this study can be used to finalize architectural designs prior to construction. Unlike other eye-tracking experiments, this study used a state-of-the-art VR system with integrated eye-tracking technology. The results showed which architectural elements

users paid the most attention to. This study's results can be used to develop practical guidelines for architects and designers for how to use spatial elements to manipulate users' visual attention and emotional responses. This study provides insight for designers about how people engage with their environments.

This study was limited in that it was only conducted on spatial elements, so future studies should be developed further to provide more theoretical implications in this field. In addition, future studies should use participants from more age groups to be able to generalize its results. Despite these limitations, the novel methodology using the VR system with integrated eye-tracking technology that allowed for quantitative analysis can serve as platform on which future visual perception and architectural studies can be conducted.

Due to the recent development of ICT technology, the use of HMD in architectural research allows users to experience virtual spaces. State-of-the-art VR technology allows users to evaluate spatial designs while immersed in them because it presents users with realistic environments that users can look around and walk through. Follow-up studies will use integrated virtual reality and augmented reality to simulate architecture while assessing participants' brain activity as well as eye movements. Face recognition technology can also be used to evaluate users' emotional responses to architectural spaces. Experiences in virtual spaces will take new forms in the future and neuroarchitecture will play an increasingly important role in optimizing the built environment for its human users.

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Reflections on the Adoption of Virtual Adaptive Learning Tool for Industrial Training

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Abstract. Ensuring proper education for employees represents a key factor in most of the industrial sectors. Several researches have been conducted in order to test the efficiency of new educational methods for improving their flexibility and effectiveness. At the same time, the introduction of emergent technologies, such as Virtual Reality (VR), is offering new solutions for industries for both reducing cost of training programmes and for better tailoring those on the needs of the users. Based on a first cross-industry reflection, the paper analyses how the combination of adaptive learning methods with VR could bring substantial benefits to companies (railway and process industry) in replacing the actual training programmes based on traditional learning approaches. Firstly, the paper offers a short overview on the features of adaptive learning and VR. Secondly, a consideration on the main requirements on railway sector and process industry is conducted in order to link them with constrains appeared during the current training programmes. Finally, possible solutions based on the previous findings are highlighted in order to sketch a possible working framework for creating a Virtual Reality Adaptive Learning Tool. Our research, thereby, shows how long-term strategic educational policies can impact the performance of the industries.

Keywords: Adaptive learning · Virtual Reality · Railway · Process industry

1 Introduction

Several companies in railway and process sectors consider the training of their employees a flagship for their development and success. In particular, major risk installations, well-known as "Seveso plants" according to the European Directive 2012/18/EU, have a mandatory learning plan to be respected, that requires to deepen the knowledge of all the plant operators about the use of dangerous substance, both during normal operations and during emergency situations.

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Using real assets for training can be quite expensive and dangerous itself and it requires to have them out of service. Therefore, nowadays companies are trying to find more effective and cost-efficient solutions.

Moreover, apart from financial and logistic aspects of the training, companies also have concerns regarding the performance and effectivity of their training from a learning perspective. General feelings and feedback point out that employees lose their interest if every year they have perform the same tasks.

All in one, it seems that the actual training programmes are not realistic enough for all employees to become engaged, demotivating them in doing all tasks perfectly, or overestimating their capabilities in irregular situations.

2 Virtual Learning Environment Model

A possible approach to overcome the mentioned problems in the previous section, namely effectiveness of the training, engagement of the trainees and cost reduction is represented by virtual learning environment (VLE). VR is a well-consolidated technology adopted in several fields from design to education.

Nevertheless, technologies in themselves do not create learning, but they do afford tasks that can stimulate learning [1]. For this reason, it is helpful, not only looking at cost reduction, but also determining exactly how a VLE can influence a learning experience. What are features that create a positive influence on learning outcomes that could be considered for a given learning objective?

Dalgarno and Lee in 2010 [2] developed a model for achieving the intended learning outcomes in a VLE. They stress the importance of immersion, which they claim to be a feature created by two factors that are unique for VLE: representational fidelity (RF) and learner interaction (LI). RF is the degree to which the virtual world is realistic. It is mainly influenced by the display of the environment, by the smoothness of the object motion and by the consistency of object behavior. LI describes the richness of the interactions, such as embodied interactions and object manipulation in order to adapt the learning environment to difference situations.

Together, these two characteristics of VLE create a sense of presence, co-presence and the construction of identity in the participant. Consequently, the participant is able to acknowledge his/her own presence in the virtual world as well as create an identity in his/her actions. These three consequences of RF and LI support the psychological sense of being immersed in a virtual world and in the performance of tasks. However, Dalgarno and Lee argue that there may be an optimum to this, which if exceeded could result in compromised learning benefits and increased costs.

Also, this model portrays a very technology-oriented view of immersion to achieve learning outcomes. Fowler in 2015 [3] argued that this model is therefore incomplete and should be elaborated by also adding pedagogical requirements to ensure that the learning outcomes are achieved.

2.1 Elaborated VLE Model with Psychologically and Pedagogically Attributes

The learning model described by Dalgarno and Lee defines immersion purely as a consequence of technology. As said, immersion is a concept that can be described not only technologically, but also psychologically and pedagogically. Fowler [3] in particular uses the concept of immersion to bridge VR technology with pedagogy differentiating three types of pedagogical immersion corresponding with the three psychological stages of learning: conceptual, task, and social immersion. These three concepts will be explained briefly in the context of skill learning:

- Conceptual immersion: this is all about demonstrating what needs to be learned. Introducing a new concept, phenomenon or process for example.
- Task immersion: the concept needs to be translated to knowledge or skill of the participants. This can be done by exploring and practicing what they have learned.
- Social immersion: if a skill is learned, it should then be put in a social context. This way, participants test their understanding of the concept or skill and its consequences.

A second focus point of VLE should be knowledge construction instead of reproduction [1]. Knowledge construction should be done with focus on both content and context. This implies that specific knowledge needs to be constructed for solving a specific problem [4].

For participants to become pedagogically engaged with the tasks, they should also be authentic. Important to state here that it is not the same as realism: a task or environment can be authentic without too much realism, and a very realistic environment can be completely unauthentic. However, to create task immersion, a high degree of realism is certainly beneficial [3]. Using authentic tasks can help build contextual and content knowledge. To create authentic tasks, four aspects are of importance. It starts with purpose, i.e. the learning goals of a virtual environment. Then, the provided contents truth is of paramount importance. This can be seen as the message that the VLE should give to achieve the learning goal, or the relationship between the real world and its virtual replacement. Thirdly, accuracy, which comes down to achieving the exact level of detail to achieve the purpose. It also implies a comfortable and non-distracting experience. Lastly, continuity should be applied throughout the experience: the level of detail should remain constant, animations should not speed up without good reason and image qualities are not changed abruptly [4].

What above appears to be confirmed also by the results of the EU FP6 funded European programme VIRTHUALIS (2005–2010), that was aimed at the reduction of hazards in production plants and storage sites. During the project one of the main end-users' practical safety issues that have been addressed was the control room operators training, proper alarm systems designing and teams' coping with emergencies [5]. The objective was met through the development of an innovative methodology, which has merged HOFs-based knowledge and VR technologies. The experimentations conducted with plant operators highlighted, through the analysis of user experiences, exactly the points of attention described above and the need for an adaptation to users' needs.

2.2 An Adaptive Learning in the Described Context

Making use of virtual or digital learning environments as discussed in the previous paragraphs opens up doors towards a trend that could be very relevant for this research: adaptive learning, a way of personalised learning in the sense that tailors the learning content towards the needs of the user. It should be here emphasised that personalised and adaptive learning are not interchangeable terms: fully personalised learning experiences also focus on tailoring learning methods to user preferences and content towards user interests, variables that cannot be changed in this research, whereas adaptive learning focuses on tailoring the content to what students need to know.

New technologies, such as VR, have the potential to allow for many ways to improve an adaptive learning experience and to overcome some of the current challenges. Some relevant affordances include [6]:

- assisting in determining a student's strengths and weaknesses; adapting the amount of instruction to the proficiency of the student;
- creating multiple lessons to target student needs and interests;
- delivering media rich instructions;
- providing teachers or instructors with data based results and analytics about student performances.

In general, adaptive learning programmes try to keep learners inside the "flow channel" [7], defined as a perfect balance between anxiety and boredom in relations with skill and challenge. In this zone, the exercises are not too difficult as to make learners anxious, but not too simple that they become bored. A nice view on how to create flow in games is proposed by Chen [8], who states that three conditions need to be met: the system needs to be intrinsically motivating, to offer the right amount of challenge as mentioned earlier and to provide the player the sense of being in control. These three conditions should be ensured in the VR simulator programmes.

There are roughly four categories of adaptive learning environments [9]:

- content discovery: adaptive techniques are used to present individual learners with personalised content during a course, possibly from other sources;
- interaction level: learning content and the course are not adapted, but the user interface and the interaction with it are tailored towards user preferences;
- course delivery: the way the course is set up, is tailored towards user needs.
- adaptive collaboration: learning processes requiring communication or collaboration are supported.

From a preliminary survey conducted in railway and process industries appears that the adaptive course delivery is the most appropriate type. It can ensure that at the end of the training each participant has the same knowledge by tailoring the offered content towards the gaps of knowledge that need to be filled for each trainee.

3 Challenges to Face for Introducing an Adaptive VLE

Implementing VLE for educational purposes also comes with challenges, namely technological and pedagogical.

3.1 Technological Challenges

Probably the most important challenge in this case is to improve the VR environments in terms of setting the scene and the experience. On the one hand, this means that the accuracy and the reaction speeds of the VR applications should be improved, and the delay of the visuals should be reduced. Currently, this causes some users to become nauseous or feel dizzy, comparable to the effects of motion sickness. On the other hand, this also includes adding more types of feedback such as smell and haptic feedback.

The second relevant challenge is to shape the experience in such a way that it allows for natural and intuitive interactions with the VR environment. A very complicated aspect indeed, because every user is different.

3.2 Pedagogical Challenges

First, finding the correct teaching strategy and matching the content is always challenging. It is widely accepted that VR (but also Augmented Reality) can enhance learning experiences if implemented correctly but the manner in which it does is always case-dependent.

Another common issue occurs while using VR especially for the first time is that of cognitive overload. This phenomenon occurs when people receive too much information or choices interfering with their short-term memory, distracting them from their original thought process [10]. Especially in VR environments, where multisensory information is used to increase the sense of presence, this can affect learning outcomes if this information is repetitive or redundant.

Finally, closely related to the latter point, there is the challenge of reducing the difficulty of using the technology. This makes longer their learning curve for mastering their own process and emphasises the need for well-thought out content that can easily adopt for their own learning needs [11].

4 Conclusions

The opportunities and the challenges discussed in previous paragraphs, despite the different scales and/or level of detail entailed in the transport and process industry, appear to be common related to the adoption of VR for operator training and learning activities. The choice of the adaptive VLE appears to be the right solution, above all where operators with different levels of skills are involved in the training. The more experienced ones resulted to be more confident in their perceptions and knowledge than in the technological tools developed for training and re-training (that is also one of the recognised sources of occupational accidents and operational errors). On the other hand, the adoption of a collaborative environment will allow to take advantage of their

experience to improve the simulations and enhance the learning experience of less skilled operators, thus overcoming in an effective way the so-called technological transfer between generations of workers.

Application of the principles here described are under development, both in the field of train maintenance (VRE for train doors maintenance) and for the process field (VRE for control room and field operators communications and interventions in case of emergency).

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Validation of Driving Simulation in a Virtual Reality Setting: The Effects of Age, Sex and Simulation Technology on Driving Behavior

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Abstract. Rapid progress in virtual reality technology empowers immersive and naturalistic driving simulations also for low budget. The technology enables researcher with the means to test different variables in road traffic riskless and reproducible. In real traffic scenarios, differences in driving behavior and safety related-perception can be observed. The object of our study was to develop a low-budget driving simulation environment and to enable a riskless testing of future traffic scenarios.

Keywords: Pedestrian safety · Virtual driving simulation · Driving behaviour

1 Introduction

The implementation of innovative road traffic technologies should always implemented with much care. Field studies that try to measure the effect of innovative road traffic technologies on human behavior may lack on safety issues (e.g. see Tesla or Google). The following study wants to contribute to a riskless testing of future innovations. In Literature, driving simulators are widely discussed [1–5]. For our purpose, we investigated two different driving simulation techniques and tried to find evidence that shows similarities between real driving behavior and virtual driving behavior. This evidence would validate a saver application of virtual traffic innovations in future, if both, real driving and virtual driving behavior will show similarities. To reach this goal we first reviewed evidence of reaction times during real driving during day and night, behavior due to different simulation technique, perception tasks in different ages and sex

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differences in real car driving. We found that during driving at night the skill for object perception is reduced and the reaction time is higher than driving at day [2, 6–8]. Regarding the simulation technology, we found some evidence for more realistic behavior, when it comes to immersive VR than desktop VR [9–11]. The effect of age on driving behavior (e.g. braking response time) shows different results: Some studies showed slower responses from older participants [12–14]. Other studies showed no effect of age [15, 16]. A third result showed that in elderly population a reduction in recognition time was observable, but no change in the time to hit the brake [17]. The main difference regarding sex is that male car driver are more involved in car accidences due to speeding than female drivers [18–21]. After the conclusion of this review, we designed a low-budget driving simulator that enables the virtual testing of traffic situations in a realistic way. Then we developed a representative street scenario of the Swiss traffic system. This included the signs and the street system of the Swiss Traffic Norms and the typical design of the Swiss landscape (cities, etc.) After this, the selection criteria for participants and the assessment were developed. The participants were ask to drive through a virtual environment and press a button on the steering wheel when they see a pedestrian standing by a crosswalk. A navigation device helped them to find their way through the environment. After the study, we compared the results with the empirical findings from real driving scenarios.

2 Methods

2.1 Virtual Environment

The virtual environment for the driving experiments had to be convincing, sufficiently large, yet fully controllable for creating and testing multiple scenarios. We focused on three key aspects for creating a convincing environment: street layouts, lighting, and the overall look of the 3D scenery consisting of buildings, vegetation, pedestrians and other road side objects. In order to create a realistic street layout, the virtual environment is based on Open Street Map data from different Swiss towns. Using real world street network data ensures an accurate mix of road types, intersections and turns while avoiding the costly manual creation of an artificial street network. The Open Street Map data was then cleaned (e.g. removal of over/underpasses) and adapted (e.g. restricting the extent of the network) where necessary for the needs of the experiments. Using the standards of the "Verband der Strassen und Verkehrsfachleute VSS" (SN 640 020a; SN 640 070; SN 640 075) 3D geometry for roads, sidewalks and crosswalks were generated using Esri CityEngine. Esri CityEngine allows the automatic creation of high quality 3D sceneries consisting of roads, buildings, and vegetation based on attributed 2D geographic information such as Open Street Map and building footprints with minimal manual work. Additional 3D objects were modeled with 3DS Max. Street lamp distribution and generation was also done with CityEngine. We placed the street lamps with a 40 m distance in-between and the SITECO Streetlight 10 midi LED 5XA5823D1A08 (IES-File) light profile was employed for realistic illumination while rendering the 3D scene. This is the standard profile, which is used for crosswalks in Switzerland for two-lane roads. To cover the differences that variable light may have on

our findings, we designed a day and a night version of the virtual environment. The two versions mainly differ in the ambient and direct lighting (sunlight) as well as the texturing of 3D objects such as illuminated windows during night. The participants' car was the only moving object in the virtual environment. Apart from the pedestrians - used as stimuli - no other people were placed in the scenery. Neither have there been any other cars. Real-time rendering and simulation of the virtual environment was entirely done with the Unreal game engine. Two routes with different conditions have been designed. Both routes exist as a day and a night version. Additionally, both routes had a virtual reality (VR) track, using a HTC Vive headset, and a standard computer screen (CS) track. While the VR setup provides a much more immersive experience – mainly by completely obscuring the physical world and enabling free viewpoint changes – The two different tracks of a route varied in light condition (night/day), display condition (VR/CS) and the position of the pedestrians. Consequently, we could guarantee that each light and display condition was used for every route. Each track contained 30 crosswalks. For 15 of them pedestrians have been positioned, demanding a reaction from the participant. The pedestrian was either standing in an open space or was partly covered by an object (e.g. tree, bicycle et cetera). The procedure of covering the pedestrians was randomized through software and it was unpredictable in which situation an occlusion would occur. The only control parameter was the number of pedestrians per track and on which crosswalks they were placed. Neither did we define if there is an occluding object nor what object it was. This ensured that every participant received another combination of situations. To prevent the participant's association of an object next to a crosswalk with the presence of a pedestrian, random object were also placed near crosswalks With this information, the navigation through the streets was normalized over all participants (all participants drove the same streets and distances).

2.2 Hardware

For the simulation itself, we used a Medion «Erazer» X5336 G desktop computer with an Intel i7-6700k, 4.0 GHz processor, 32 GB RAM, and a NVIDIA GTX 1080 FE graphic card. The steering wheel was a Thrustmaster T150 RS and the pedals a Thrustmaster T3PA – Pro Pedalset. The participants have been seated on a PlaySeat gaming chair. For the computer screen (CS) simulation we have been using a Samsung 5 Series LED-TV with a screen size of 32″ and a resolution of 1920 × 1080 pixel. The VR-Headset was a HTC Vive consisting of two OLED displays with a resolution of 2160 × 1200 pixels that was also tracking the head motions. For this study, we define

reaction time as the time elapsed from the moment the stimulus (pedestrian) becomes visible until the participant produces a reaction. When the participant approaches in the car a crosswalk with a pedestrian standing aside, the participant had to press a button as soon as the pedestrian was perceived. The pressed button is registered by the simulation as the participant's reaction to the visual stimulus. To compute the first possible moment a pedestrian appears in the field of view of the participant, a raycast method was applied. For the measurement, a timer was started by the ray intersection and stopped by the button press of the participant. If the participant failed to press the button, the timer automatically expired when the crosswalk was passed. To avoid driving mistakes affecting the simulation, the collision with obstacles was deactivated. This setup enabled comparing the effects of the mean individual reaction times in the different driving conditions in a standardized way.

2.3 Participants, Experimental Design and Procedure

40 (18 women and 22 men) invited participant joined the experiment, while 32 participants completed the study. We tried to keep the distribution of the sexes as similar as possible to the distribution we find in the swiss road traffic. All of the participants carried a valid driver license. We utilized a multivariate, multifactorial, within-subjects design. As independent variables, we used different visuals (CS vs. VR), light (night or day), route, age and sex. The dependent variables include reaction time and average speed. The task was to drive a certain route in the virtual environment, guided by the head up display in the car. The participant also had to press a button at the steering wheel, when a person standing beside a crosswalk came into view. No additional reaction (e.g. braking before the crosswalk when seeing a person) had to be accomplished. Furthermore, to reduce possible confusion, the speed limit for all routes was set to 50 km/h. All trials were done at the Virtual Technologies and Innovation Lab of the School of Applied Psychology.

3 Results

The results showed a significant main effect of the simulation method ($F(1, 124) = 424.688$, $p = .000$) and the light conditions on the reaction times ($F(1, 124) = 6.168$, $p = .014$). No interaction was found. The reaction time was lower in VR than in the CS condition (see Table 1).

Table 1. Mean reaction times in sec. in different conditions

Display	Day/night	Mean	SD
Monitor (CS)	Night	10.89	1.28
	Day	10.40	1.24
HMD (VR)	Night	6.33	1.0
	Day	5.71	1.48

No effect in of age was observable, but male driver drove faster ($p < .05$) in the virtual environment than female driver (see Table 2).

Table 2. Mean reaction times in sec. in different sex groups

Display	N	Mean	SD
Men	18	42.47	3.33
Woman	14	37.69	4.80

4 Discussion

This study aimed to find evidence that shows similarities between real driving behavior and virtual driving behavior. We could show that similar to the real world [18–21] male driver also tend to drive faster in the virtual world (eventually with more risk) than female driver. This is independent from simulation technique. The simulation technique itself has an effect of reaction time as it was found in [9–11] when it comes to recognition of pedestrians. In VR condition the driver were about 4 s faster than in the SC condition. We also found the same ratio of slow to fast reaction when you drive a real car at night or at day in the virtual setting [2, 6–8], with higher effects in the VR condition. When it comes to age, as previously reported [15, 16], no effects were found. Overall, we could show that a virtual driving simulation environment is able to evoke naturalistic driving phenomena (that can be observed from real driving scenarios). This could be a useful tool in the future for safer testing new traffic related innovations.

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Using Virtual Reality and Gamification for a Restorative Therapy and Rehabilitation Support Equipment

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Abstract. Current literature demonstrates that the use of both VR technology and gamification can benefit rehabilitation, providing an increase in motivation, a more active user engagement and overall a more fun and joyful experience. This article presents the design of a VR application with the incorporation of gamification elements for a physical rehabilitation equipment. A detailed description of the equipment is made for further understanding of the project. The VR application allows the customization of rehabilitation sessions according to patients' needs. Furthermore, the application was presented to the medical team of a Portuguese rehabilitation centre (Rovisco Pais) and had great acceptance.

Keywords: Engagement · Gamification · Motivation · Rehabilitation · Virtual Reality

1 Introduction

The physical rehabilitation process of a patient is a difficult and painful task which requires the repetitive execution of exercises over a long period, typically in spaces with few stimuli. These exercises are performed by using adapted gym machines which do not have the necessary technology to provide feedback that allows an autonomous correction of patients' body posture, thus depending on the medic professionals who accompanies them. The rehabilitation process, being monotonous and lacking evolved machines/systems, eventually becomes tedious negatively affecting patients' motivation levels, which is an important factor that determines therapy outcome [1]. A lack of

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motivation is a barrier to adherence to therapy [1, 2], which can lead to a slower progress and evolution of a patient's recovery process.

Virtual reality (VR) has long been recognized as a technology with a great potential for multiple areas including physical therapy [3–6]. As far back as in the 90's, researchers identified benefits such as: (1) enabling physically impaired people to accomplish tasks and have experiences that would otherwise be denied due to physical limitations [3, 5]; (2) creation of tailored virtual environments (VE) according to different disabilities in order to make patients perform specific tasks [4, 6]; (3) support tool for physicians in the diagnosis of physical disabilities [4, 5]; (4) increasing motivation during motor tasks, as well as facilitating motor learning through multimodal sensory information [6]. VR only gained popularity in the following years with several studies [7–11] reaching similar conclusions when it comes to the benefits of the technology in rehabilitation. There is a consensus when it comes to VR-based rehabilitation programs prompting more fun and enjoyment, leading to an increase in motivation and engagement, when compared to conventional programs [7, 8, 12–14], however there is not enough evidence that suggests that they are more effective [15].

Gamification, which can be defined as the use of game elements in non-gaming contexts [16], can be incorporated in VR applications to improve user experience and user engagement, and to foster motivation [9, 17–19]. The term Gamification is often confused with the term Serious Games. Whereas Serious Games describes the design of full-fledged games for non-entertainment purposes, gamified applications merely incorporate game elements [20]. It has been demonstrated that well-designed computer games can be motivating and highly engaging, benefiting rehabilitation in general [21–23].

The work described here, which is an integral part of the development of an equipment for restorative therapy and rehabilitation support, designated Exobike, aims, amongst other features, to provide the missing motivational component in the traditional systems mentioned. This system focuses on the rehabilitation of individuals who have suffered injuries in the lower limbs, as well as in the recovery, training and early diagnosis of patients with physical and neurodegenerative diseases. The Exobike project is being developed with "Centro de Medicina de Reabilitação da Região Centro - Rovisco Pais", a rehabilitation centre in Portugal, Coimbra.

The aim of this work focuses on the design of a VR application with the incorporation of gamification techniques. The application's intention is to be able to provide the patient with visual, auditory and haptic feedback regarding their gaming performance and motor behaviours in order to encourage the patient to perform their rehabilitation tasks, and to allow an autonomous body posture correction, while providing medical professionals with consistent data needed for the diagnosis and evaluation of the patients' evolution.

2 Exobike System

The Exobike is a bicycle-like mechanical structure that takes over the function of an exoskeleton which contains a set of sensors and actuators that enables a dynamic system that can adapt to patients' needs. Patients' movements are monitored through a

set of wireless sensor networks, complemented by a virtual reality solution strongly related to reality. The system has the ability to collect, store, and manipulate patient medical data that can later be reviewed by qualified medical professionals. The Exobike setup (as shown in Fig. 1) is composed by the following elements: (1) A monitor for medic professionals to monitor the rehabilitation sessions by means of a web app; (2) A monitor displaying the VE, when running the application in a non-immersive setting; (3) A desktop computer that runs the VR application, processes the sensors' data and acts as a local server storing sensors' data and hosting the web app; (4) A VR headset to display the VE, when running the application in a fully immersive setting; (5) A bicycle with incorporated sensors where a patient performs the rehabilitation sessions; (6) An electronic device to transmit the data captured by the sensors.

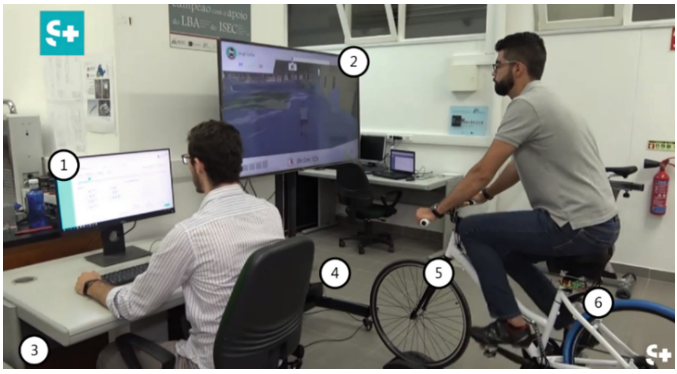

Fig. 1. Exobike system in a testing environment. (1) Monitor 1. (2) Monitor 2. (3) Computer. (4) VR headset. (5) Bicycle and sensors. (6) Electronic device.

The architecture of the Exobike system is divided into three main modules: Bicycle & Sensors, Central Processing and Clients (Medical Professional, Patient and Virtual Reality) as evidenced in Fig. 2.

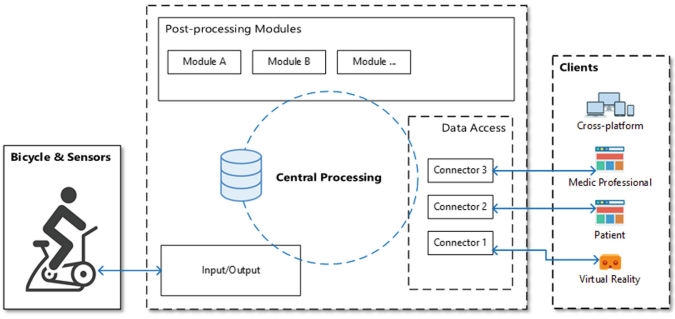

Fig. 2. Architecture of the Exobike system

The "Bicycle & Sensors" module consists of the mechanical component (adapted bicycle and support structure) and the multiple sensors. The "Central Processing" module is where all processing, storage and data flow from sensors and clients takes place. The "Clients" module is composed of web clients (Professional Medic and Patient) and the Virtual Reality client. The Medical Professional and Patient clients are two types of users of the web application, who have access after authentication, to a set of features specifically developed for each user type. It is through the web application that a medical professional will monitor the rehabilitation sessions and evaluate the patient's progress. A patient can also, through the web application, visualise several data related to the sessions he/she previously participated in.

3 Gamifying the VR Application

The VE, as shown in Fig. 3, was designed in order to simulate a real environment. It has different scenarios with landscapes familiar to the patients, near the rehabilitation centre, where there several trees, a lagoon, buildings, animals, and fixed circuits that the patient will have to follow. These circuits vary in distance and elevation enabling the possibility to increase and decrease difficulty, thus allowing the creation of rehabilitation plans with different levels of difficulty. One of the first things a medical professional needs to do before starting a session is defining the main goals for the patient's session, which can be: (1) the number of laps to travel in a circuit; (2) a duration to complete a circuit; and (3) a speed for the patient to maintain. Both rewards and goal-setting are key factors in game design, as they lead to an increased motivation and engagement [22]. Before and during a session, both the goals and the instructions for completing the required tasks are displayed in the VE, as it makes task execution more efficient [22] and improves performance [24]. Giving the patient feedback during a session is also very important, as it will enable the patient to measure his/her progress in achieving the goals defined [25] as well as to autonomously correct his/her body posture. The progress of a patient will be measured by using the progress bar element, when it comes to goals (1) and (2), and by a visual indicator, regarding the goal (3), that assumes the colour green or red if the patient's current speed is within or without a specific speed range based on the defined speed goal. Regarding the body posture of a patient, feedback is given by using positive text messages and a visual indicator that shows the patient's centre of gravity in the saddle. In order to reward goal achievement, points and badges elements are used. Points are accumulated when a patient completes 25, 50, 75 and 100% of goals (1) and (2), and every time the current speed is within the range. Badges are given when a patient reaches different number of points, and when a goal strike is achieved (e.g. The patient achieved 100% of a defined goal for two consecutive sessions). Another key aspect is the incorporation of competition elements, which is determinant to enjoyment and allows an active engagement of the patient [26]. As competition with other patients would be unfair due to different medical conditions, self-competition is incorporated. To do that, the individual leaderboards element is used in order to display the sessions with best performances regarding a certain goal. Also, during a rehabilitation session the details of the last session are displayed in the VE to reinforce improvement. The game elements used in the application were

carefully chosen, considering that each one of these elements fulfil different functions and are linked to one or more motivational mechanisms [17, 18].

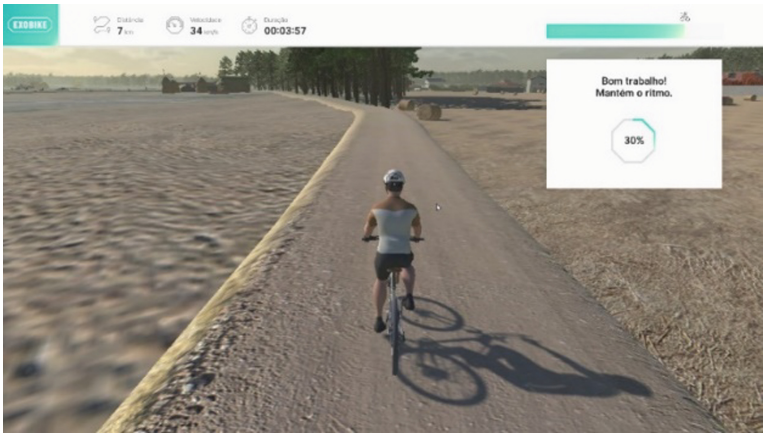

Fig. 3. A patient riding the bicycle during a rehabilitation session in the virtual environment

4 Conclusion and Future Work

The VR application designed offers the possibility of tailoring rehabilitation sessions to patients with different physical and psychological needs. A prominent factor in the application is the incorporation of the time limit design element, which is not common in gamification, even though it tends to be more effective according to goal-setting theory [24]. The work presented here was greatly accepted by the medical team of a portuguese rehabilitation centre (Rovisco Pais). The Exobike project is currently under development, and the final prototype will be tested and validated in both hospital and homecare environment.

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Training in Immersive Virtual Reality: A Short Review of Presumptions and the Contextual Interference Effect

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Abstract. The increase of shipped consumer immersive virtual reality (IVR) up to 6 million units in 2019 shows the increasing popularity of this medium. Invests of 8 billion dollars are anticipated in the next five years for the training sector. With the development the question arise, what effects and advantages can be expected using IVR in human training? This paper reviews three important areas, when it comes to the design of immersive virtual reality trainings: 1. cognitive load, 2. spatial imagination and the contextual interference effect.

Keywords: Immersive virtual reality training · Contextual interference effect · Training design

1 From Computer Based Training to Immersive Virtual Reality

Virtual, computer-based learning and training environments have been around for decades. Their manifestations range from text-based and image-based learning programmes [1], learning tools [2], simple video-based coaching (e.g. Lynda.com) to clinical trainings [3]. Based on the field of application the learning content should portray or enrich real-life experiences by using videos and animations. To achieve this goal, most computer-based and smartphone-based E-Learning programmes present 3D models on a screen in 2D (Desktop-VR). In this use case, the interaction is often limited to the use of a computer mouse with the room sensory and/or motor activity being excluded. The user-generated content is shared in online forums (e.g. Moodle) and users can communicate by using (Video-) chat and screen-sharing software (e.g. Skype, TeamViewer). Furthermore, the acquisition, practice, and testing of learning material can be promoted by doing multiple-choice tests, word completion tasks, matching tasks, etc. and can be supported by avatars (pedagogical agents). To promote the immersion into the virtual worlds, virtual reality headsets (iVR) present the

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information in 3D, enable stereoscopic vision and improve the opportunity to interact, hereby enriching the feeling of being present in the virtual world. The experience can be enhanced, by creating one's avatar to experience, create and communicate with others in a community without the requirement of being physically present in the same place. Similar to the real world, using iVR, several people can collaboratively create, share and save virtual objects, processes, and spaces online (e.g. Modbox). The processes of computer-based training and testing can be designed in a way to be more realistic and to better portray real-world tasks and situations. Next to the established techniques, this can be achieved by implementing motor-based interactions (e.g. construction and dismantling of a machine), adaptive and time-controlled processes (e.g. biochemical reactions in a cell) or the incorporation of 360-degree videos in simulations. The above-mentioned opportunities to promote the quality of interaction, communication, and creativity in virtual reality raise the question of efficacy. What are the benefits of immersive iVR compared to desktop-VR? Is the extra effort and expense justifiable by a similar or greater improvement in learning outcomes? The empirical evidence is wide-ranged and not conclusive. In the field of learning in virtual reality, there are important subject areas, that should be considered when designing iVR training: Cognitive Load, Spatial imagination and learning paradigm.

2 Cognitive Load, Spatial Imagination and Learning Paradigm

During learning with a multimedia environment, it is important to keep the cognitive load (CL) on a medium level, because a high degree of CL can interfere with the learning process [4]. Besides questionnaires [5], brainwave parameters (measured with electroencephalography, EEG) can be used as objective psychophysiological correlates for the measurement of CL [6]. The degree of CL is called the Cognitive Load Index (CLI). A high CLI is tantamount to a large amount of objective CL whereas low CLI is equivalent to a low amount of CL for the brain. High CLI can, for example, emerge as a result of diffusion when solving a problem and simultaneously be overstimulated by the high level of detail of 3D models on a 2D screen (e.g. computer or smartphone) [7]. In a study, Dan and Reiner [8] illustrated that in certain brain areas, CL measured objectively with CLI by EEG, is lower when learning in virtual worlds supported by avatars and focussed on the learning material by HMD-VR. When the same 3D content is presented in the virtual world on a 2D display, CLI is elevated. Makransky et al. [9] demonstrated negative effects on learning and the CLI, if the VR learning environment was not designed in a task- and/or user-centred design process. Therefore, the inclusion of the target group in the design of the virtual learning space seems to be an important factor relevant to the learning success and CL. In addition, spatial imagination is an important factor. Hulk [10] showed in his study, that independent of the spatial imagination abilities, learners needed more learning time when 2D-Learning-Tools used 3D-Animations. At the same time, students with lower spatial imagination abilities seem to benefit more from the presentation of the learning material in iVR [11]. Whether learners with high spatial imagination abilities also present with lower physiological stress parameters has yet to be studied. The aspects "CL" as well as

"learners" abilities however are highly relevant for the application in the field of training. Furthermore, contemplating the influence of the opportunity to interact (designing controls and movements) in virtual reality, results on learning efficacy are mixed. Sugand et al. [12] observed large learning effects (i.e. faster processing time and reduced error rate) in medical training for surgeons. Likewise, Webster [13] observed higher learning success in user-centred designed training in iVR, compared to the control group (PowerPoint presentation). Children between the age of 6–8 for spatial matching tasks [14] as well as engineering students [15] benefited from using iVR, compared to control groups and/or other VR-Groups, the most. Additionally, elderly people seem to benefit from iVR in memory performance [16]. Conflicting to the above-listed studies, Phé et al. [17] did not observe any learning effects after VR-Training in novices and experienced physicians. Only people with no background in medicine showed improvements over time. Only Våpenstad et al. [18] and Makransky et al. [9] could find no effect through iVR. At this point the intended learning success needs to be defined and a learning paradigm must be suggested. Applying pedagogy to the design of VR training is not easy. Although the current empirical knowledge indicates a positive impact of iVR, studies with contrary results can also deliver useful indicators on how to design effective training in virtual reality. The majorities of VR-Training studies focus on the development, usability and the feeling of immersion and lesser on learning efficacy and a meaningful didactic conception. However, psychological learning research offers didactic principles that can be especially useful for improving the learning transfer of skill-learning. Studies that used didactic and psychological paradigms together with a user-centred design approach of the training, showed a positive effect of iVR on the learning success (e.g. [13]). Studies without this pedagogical and/or psychological approach where learning transfer was measured as an indicator of learning success but not the main focus in the design of the VR learning space, showed a negative effect of iVR on learning success (e.g. [9]). Therefore, the successful use of iVR as a training tool might be dependent on the proper training design based on empirical learning paradigms and with a user-centred approach. One of those learning paradigms is the contextual interference effect (CIE).

3 Context Interference Effect and IVR Training

The hypothesis states, that high contextual interference would impair the acquisition but enhance the retention and transfer of learning [19]. The CIE was first investigated by Battig [19] in the instance of learning word-pairings. The hypothesis was later adapted by Shea and Morgan [20] in motor learning, where the CIE has mainly been a subject of interest [21]. By reviewing the scientific literature about the CIE, it becomes evident, that the manipulation of practice schedules (blocked vs random practice) is the only source of interference used in the vast majority (if not all) of the studies. In the CIE studies, blocked practice as low degree of interference (learning the same task several times in a blocked order before moving on to the next task. E.g. AAA, BBB, CCC, etc.) is compared to random practice as high degree of interference (learning the different tasks in a random order. E.g. ACB, CBA, BAC, etc.). Using HMD-VR, the CIE-Paradigm can be much easier implemented in a virtual training environment

compared to the real world. For example, in virtual reality, complex procedures can be practiced in a randomized order without constraints of the physical world. In contrast, learning in the real world can be constrained to the extent that randomized training is not always feasible. The promising impact of CIE relevant to the transfer of the learning content presents an additional interest in the paradigm for HMD-VR. A wide range of VR Training studies focuses on real-world tasks as e.g. manufacturing assembly (e.g. [22]), neurologic surgery (see [23]) and military training (e.g. [13]). Those VR training programmes are often created to promote the transfer of the learnt skills into the real world. By systematically implementing CIE in HMD-VR, there might be highly beneficial effects on the transfer of learning to the real world. The CIE has been studied in a wide range of areas as e.g. in sports (e.g. [24]), simple tracking tasks (e.g. [25]) and simple motor skill learning (e.g. [26]). Comparing those CIE areas of interest to the complex real-world tasks that present themselves to be good candidates to transfer the learning process into virtual reality, there appears to be a relevant gap. By reviewing the literature on CIE, only a handful of studies might be comparable to real-world tasks and therefore relevant information sources for the design of training courses and/or studies for HMD-VR. The identified studies are presented in Table 1. By analysing the identified studies, study-design principles for future CIE studies in VR should be identified.

Table 1. Identified CIE studies to address complex real-world tasks that present interesting similarities to the identified HMD-VR studies

Study	Skill that is learned in study	Number of tasks	Amount of task repetition
[27]	Training orthopedic surgical skills	5	5 × 5 (whole vs random vs blocked)
[28]	Troubleshooting skills	4	5 × 4 (blocked vs random)
[29]	Troubleshooting skills	4	12 × 4 (blocked vs random)
[30]	Stick and rudder flighting	13	10 × 13 (whole vs blocked vs sequenced)
[31]	Laparoscopic surgery skills	4	20 × 4

By analysing the different studies in Table 1, there seems to be a wide range of different training structures (e.g. the number of tasks and amount of repetitions of each task). Additional studies in the area of real-life tasks are needed to gather further information related to CIE and design of training with the focus on transfer success. In a meta-analysis, Brady [32] pointed out, that the practice schedule manipulation (blocked vs random practice) is the only source used to generate interference in the identified studies and that other sources of useful interferences need to be identified. Originally, Battig [19] argues that there might be several sources of interference within and external to the learning task. By reviewing the CIE literature, there still seems to be solely focus on practice schedule manipulation. Virtual reality studies could present themselves as helpful instruments to advance scientific knowledge on the CIE. Other

sources of interference as e.g. lighting quality in a factory, background noises in the operating theatre, degree of scaffolding presented during learning a manufacturing assembly task, etc., could be easily designed and investigated. Conclusively, based on the gap in scientific knowledge about the CIE referred to complex real-life tasks and possible sources of interference on one side and the need of applying pedagogic/psychological learning paradigms in VR training on the other side, the exploration of those two research areas and their interaction, seems to be highly relevant for science and the industry.

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3D Multi-user Virtual Environments in Education

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Abstract. The aim of the paper is to highlight the importance of 3D virtual reality and 3D multi-user virtual environments as a support and complement in education. What influence and impact to education represents virtual and augmented reality? Using in teaching is directed towards learning objectives? Let us point out virtual social relationships, social community and 3D virtual simulations.

Keywords: 3D multi-user virtual environments · Virtual reality · New trends in education · Education 4.0 · Digital technologies · Research

1 Introduction

According to [1]: "*virtual Reality (VR) allows social interaction between users through virtual avatars that meet in the virtual reality environment, where they can communicate in a manner very similar to real-world communication*". It uses methods of experiential learning, simulation learning, 3D models and principles of connectivity and constructivism e.g. – using virtual simulations of real professions [1, 2].

Nowadays, the demands on psychological resistance of students in the environment of cyber and robotized world are changing. The paper attempts to define goals and visions for the future and integration into the teaching process are mentioned and its main advantages and disadvantages. The paper responds to the new trends and needs of a society whose competitiveness requires population readiness to industry claims 4.0 as well. It is possible to name the positive and negative aspects of 3D multi-user virtual environments and to overcome contradictions by seeing the positive and negative impacts on the young generation [2]. It is particularly important to compare the views of teachers and students.

The study will serve as a basis for a research on digital competences of secondary vocational school teachers, that is currently carried out at the Masaryk Institute of Advanced Studies, Czech Technical University in Prague (CTU), as part of a research grant from the Czech Technology Agency (project number TL01000192 - Developing digital competence of teachers of social sciences and secondary vocational schools).

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2 New Objects Focused on 3D Multi-user Environments in Education

At first, we can say - can digital technologies significantly affect the teaching process? We mean for example [2]:

- Virtual laboratories.
- E-technology park - remote and virtual laboratories.
- Virtual class (classroom).
- Virtual, augmented and mixed reality in education.
- Artificial intelligence.
- Programming and robotics.
- Blended learning.
- Flipped classroom, re-design places.
- M-learning.
- Gamification and microlearning.
- Cloud solutions, IoT (Internet of Things).

Nowadays, higher education institutions support their teachers and develop the skills on-line and other forms of education opened up by the digital era (mobile era). Modern institutions exploit the opportunities presented by digital technology to improve the quality of teaching and learning. It is recommendation of the European commotion [3]. According to [4], we live in digital era (mobile era). We know, we have industry 4.0 and education 4.0. The combination of man and machine allows for new possibilities. The potential of digital technologies is exploited. It introduces a plan for future education, for lifelong learning. We mean from children's education to continuing education in the workplace. The most important are new methods and ways of learning. The purpose of the digital education strategy is [5, 17]:

- open education to new methods and forms of learning through digital technologies,
- improve students' competences in information and digital technologies,
- develop students' IT thinking.

We have a **competency model** of a teacher working with digital technologies. Very important are pedagogy planning and teaching with digital technologies. For example - to work on projects, to improve creativity, lifelong learning and teacher cooperation, to use 3D multi-user environments [5, 6]:

- Strategy (knowledge of goals, classroom practice).
- Content of education and learning environment (teaching planning, learning environment, pupil's role, assessment, communication and cooperation, special educational needs).

- Pedagogy (planning, problem teaching, pupil's experience, ethics and risks of virtual space, cooperation, projects, creativity).
- Digital technologies (software tools, authoring tools, internet, communication and collaboration, administration, learner learning).
- Organization and Administration (digital Technology Integration, Class Management, Appropriate and Legal Use).
- Further education (planning, teacher cooperation, non-formal learning).

And what about virtual reality in education? Nowadays, digital technology, technology development and 3D multi-user environments are dynamic and rapidly changing. Teachers will be able to distinguish which type of environments are suitable for a particular teaching topic. And it is necessary to be digitally competent. It is essential to know which technologies we mean. Which technologies are used and will be used in the educational process. And then carry out research. Virtual reality, augmented reality and mixed reality are important educational tools today. What do teachers need? [2, 6]:

- They were digitally competent.
- They knew the advantages and disadvantages of using 3D multi-user environments in education.
- They were able to distinguish which type of environments is suitable for a particular teaching topic.
- They had an idea of the influence of virtual reality on students' learning outcomes.

Mainly, **digital competences** are a set of knowledge, abilities, skills, attitudes and values that an individual need to be able to use digital technology for his/her own benefit and for society. However, there is a lack of systematic summary of research findings in the field of digital competences of teachers, who can be considered the main actors of paradigmatic change in education. It is, therefore, appropriate to analyse the research studies carried out in the area of digital competences of teachers, which will enable the reflection of the current state of knowledge in this area focus on 3D multi-user environments. Being digitally competent, therefore, means being able to critically and independently use the full range of digital technologies in gathering and processing information, in social interactions, disseminating knowledge and solving problems from different areas of work and private life [2, 6]. A lot of students are motivated to learn with mobile technologies. 3D multi-user environments combinate gamification and **m-learning**. According to [2] and [7]: "*m-learning also combines **extended virtual reality** such as learn languages in **augmented reality**. We can use adaptive learning technology, virtual tutor and ChatBot to learn and learning is faster".* Nowadays virtualization and gamification are more popular and more efficient for using methods and achievement of goals in teaching. We would like to point out interest in introducing AR, mixed reality and 3D models into teaching in elementary schools. More and more students approach the augmented reality positively, better learn, understand and remember [4, 8].

3 Trends in Education Using 3D Multi-user Environments

There are frequently discussed questions in education using 3D multi-user environments [1, 9]:

- Possibilities of using virtual, augmented and mixed reality and their impact on learning outcomes.
- Positive and negative effects on the teaching process.
- Students' opinions on teaching in this environment.

3D multi-user virtual environments have already existed at MIT, Harvard University, University of Texas, Valdosta State University, New York University, Vassar College, Oxford University, Derby University, Nottingham University, Leicestershire University etc [1]. **Teaching in 3D multi-user virtual environments** is defined as "*a simulation of a real environment in which multiple users can communicate in one place in real time*" [10]. The main disadvantages can be health problems related to the excessive use of virtual environments, technical problems during the work, the necessity to train teachers and students to work in the environment, and the financial demands of creating custom 3D objects. According to [1, 9] 3D multi-user virtual environments helps to apply the principles of constructivism and connectivism to the educational process (requires active collaboration of people in manipulating 3D virtual objects - work in groups or in pairs). It helps to apply the principles of experiential learning, experimental learning, problem learning, role playing and game-based learning (gamification). It strengthens the principles of community learning and shared learning. The feeling of personal identity in fulfilling assigned tasks and exercises in a virtual environment. This environment seems to be most suitable for the 2nd stage of primary school, then for secondary schools and finally for universities. Technical and organizational preparation and training of teachers are required so that the instruction is smoothly realized (Fig. 1).

Selected examples [1, 11]:

- Game-oriented teaching (War of Worldcraft, The SIMS).
- Story-based teaching, role playing (Jane Austen world, Poets of II. WW).
- Space for debates, brainstorming, community projects - the principle of visual social network (Second Life, Kitely).
- Virtual simulation of real occupations (experimental learning, simulator).
- Multimedia interconnection of 3D space and real environment, virtual building for learning (new learning objects for learning foreign language, cyberculture and new media).

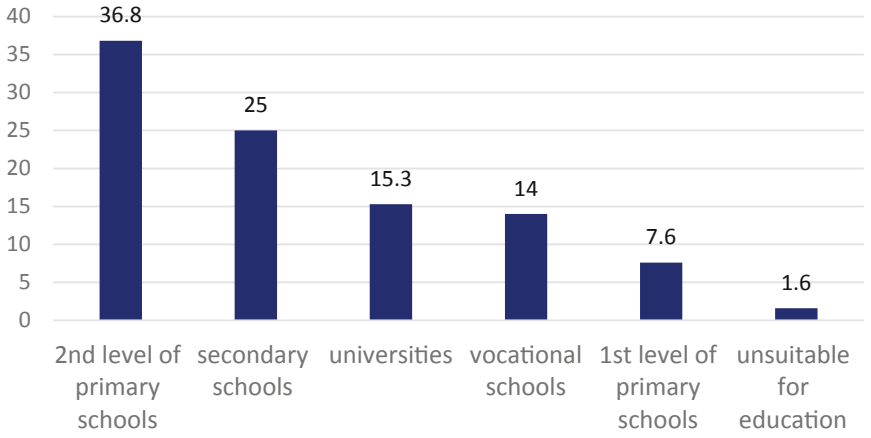

Fig. 1. Research results - for which level of school is learning in 3D multi-user virtual environments best suited (in percent) [1, 12].

4 Conclusion

How to educate for the future? As [13] said "*Train your brain - thinking critical and logical, develop creativity, autonomy and flexibility, let's cooperate and communicate, let us understand the basic principles in many fields, it is better to create the future than to adapt"*. Education 4.0. corresponds with innovative methods and forms of education with using digital technologies [2, 14]. Lifelong learning is very important and produce new knowledge. Possible outcome might be the designing of digital technologies courses for teachers to improve their knowledge and skills and help them find ways to incorporate virtual reality into their teaching. This is also one of the goals of our main research project under the Technological Agency of Czech Republic.

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Early-Detection and Treatment of Torticollis in Infants Using Augmented Reality

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Abstract. Pediatric physical therapists (PTs) have long struggled to diagnose and treat congenital muscular torticollis (CMT) at early stages, when such diagnosis and treatment would do the most good. Much of this problem is that very young infants and toddlers have difficulty with poses, are difficult to measure due to their small size, lack of compliancy, and inability to remain stationary. It often takes a team of pediatric PTs to perform these measurements, and usually in a clinical setting. We wish to create a toolset and a methodology that allows for simpler diagnostics, more comprehensive monitoring and treatment, and wider access to such care and treatment by creating TorticollisAR - an Augmented Reality (AR) application that performs critical measurements in a familiar, convenient setting (such as the home). The app uses tracking markers integrated into either bands or clothing to take measurements in real-time and while the subject is in motion.

Keywords: Augmented Reality · Artificial intelligence · Pediatric physical therapy · Congenital muscular torticollis (CMT)

1 Introduction

Due to an increased awareness and more vigilant monitoring, pediatric physical therapists are diagnosing more and more infants with congenital muscular torticollis (CMT) [1]. This condition is the result of a tightening of the sternocleidomastoid (SCM) muscle which presents as a rotation away from the tightened SCM and a lateral tilt aligned with this tightening. It often presents at birth or shortly postnatal. The goal of the intervention via therapy is to increase the range of motion (i.e., improved active adjustments of the angle of the neck while being tilted, passive alignment with posture and body position, etc.) in the side-to-side bending of the neck, as well as in the rotation [2]. The restrictions, and the resultant natural compensations by the infant, can result in a bent (tilted and rotated) neck, raised shoulder, or similar accommodations. These additional issues can further restrict or impede the much-needed measurement process used during assessment and treatment.

In standard practice, pediatric physical therapists use both active and passive measurement techniques for assessing CMT. One common practice is to hold the infant

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and slowly tilt them to one side. While doing this, they wish to measure the angles of rotation and tilt of the infant's neck with respect to their shoulders. Passive measurements techniques include visually estimating these angles (the angle of the shoulder line, the angle of the head, the delta between those two). This is inherently unreliable other than for a general verification of an issue but is more convenient than actively measuring these angles with an apparatus. Active measurement usually requires additional assistance due to the number of hands required to perform the manipulation and to hold the measurement devices. In both cases, there is the possibility of missing vital measurements or negatively influencing the accuracy during the manipulations [3]. We wish to increase the reliability and accuracy of the visual measurements by utilizing Augmented Reality (AR) markers to track, in real time, and display the angle and rotation of the head, the angle and rotation of the shoulders, and to calculate and display the differential for reference. It is critical to track these metrics over time during the manipulation to understand the infant's ability to adjust and correct their head position with respect to their torso. Further, storing these measurements across time will allow the pediatric physical therapist to track progress across the duration of the intervention.

If ultimate precision were the goal, then we could take highly detailed 3D mappings (e.g., point clouds, stereoscopic imaging). However, this would require extensive setup and utilize expensive tools, both of which mean that this is unlikely to be useful in the field. The goal is to interact, intervene, and treat CMT in the field. Further, it would be advantageous to have a tool useable by the parents or caretakers of the infant as well. To that end, we need to have a portable solution that is both affordable and reliable. Naturally, the proposed solution must also be accurate and valid. There are measurement tools that exist that utilize phones as angles of measurement devices, but they fall short in assessing multiple angles at once as well as not calculating the differential. Even more advanced goniometric measurement applications fall woefully short of the convenience, accuracy, and usefulness that is required. Our solution is an Augmented Reality (AR) mobile app. This application can measure the desired angles in real-time, providing feedback in AR to the person performing the evaluation, as well as comparing these angles to give a measurement useful for diagnostics. The reliability and validity of this mobile app will be demonstrated in infants with congenital muscular torticollis to characterize isolated neck active motion and muscle length. The ability to differentiate among the contributions of each factor will improve objectivity and accurate evaluation.

This project's goal is to create an accurate, AR-based phone app that allows real-time measurement of angles between an infant's body segments while held by an adult. It also assesses the orientation of the body to the environment. This application is projected to provide an affordable, portable, accurate method of neck motion measurement that can be accomplished by an individual physical therapist who is holding and tilting an infant. This will allow the therapist to use the app in both the community and the clinic to instantly measure the infant's neck active range of motion and document progress. This early detection, intervention, and treatment is possible because of the low-cost, easy to implement application built in AR for mobile devices.

We utilize an intelligent, model-based, hierarchical, artificial intelligence framework that we created to provide real-time analysis and feedback in AR [16]. This AR

tool is able to harness the power of multi-processor computing, GPU-enhanced graphics rendering and calculations, and high-performance computing because of this cutting-edge framework. Additionally, because it has the ability to project these resources across mobile devices, it can be deployed in the healthcare community and not just in clinical settings. This paper explains the process by which this framework is built, trained, deployed, and utilized by clinical practitioners. It details the process of harnessing immense computing power in mobile devices via shared model learning. Additionally, it documents the AR application's toolset, usability, and effectiveness. The final result is an application that can be used by educators for teaching, medical professionals for diagnostics and treatment, and by parents for therapy and constant quality of life improvement for their children.

2 Background

There has been a lot of progress in the area of visual markers. There are many techniques available, such as point cloud devices (like the Microsoft Kinect), IR motion trackers (like time of flight systems with larger 'ball' markers), AR pattern-style markers (like QR codes), or basic blob recognition (as seen in computer vision) [4–6, 12]. For our purposes, we needed something with a simple setup (so we could not use anything external for tracking) and a light footprint (so that it can be implemented nearly anywhere). Additionally, there is very little surface area on the subjects (typically infants or small children), so larger markers that need high-resolution will not work [7, 11]. We opted for a custom-built blob recognition because we can use distinct colors on a variety of surfaces for our markers. There are several applications that were informative and may serve as reference, such as [13], where robotic applications demand the accurate tracking of end effectors and other robots, or [14, 15] that offers a treatise on recent advancements on AR tracking techniques and modalities. We built on these advances to create our customized tracking system.

3 Purpose

Congenital muscular torticollis (CMT) is a condition in which infants exhibit tightness of neck tilt to one side and rotation toward the opposite side. Unilateral sternocleidomastoid muscle tightness occurring in or around the birthing process typically causes CMT. The sternocleidomastoid (SCM) muscle attaches to one side of the back of the skull just behind the ear and to the same side collarbone (clavicle) and breastbone (sternum) resulting in head tilt to the same side and rotation away from the side of SCM tightness. This pattern of attachment also causes the infant to compensate for limitations of range of motion in one direction with a different motion such as rotation or raising the shoulder on the tight side.

In response to the increasing number of infants being seen by pediatric physical therapists for CMT, the Section on Pediatrics of the American Physical Therapy Association created a clinical practice guideline (CPG) for CMT in 2013 which was recently updated in 2018. In both of these guidelines, one of the primary factors that must be

examined is active neck rotation and active neck lateral flexion or righting the head in response to tilt. Multiple studies have validated techniques that measure passive neck rotation and lateral flexion while stabilizing the infant's body [8, 9] and posture [10]. However, only two techniques have been identified for examining active neck motion. Because both techniques require the therapist to hold the baby, the therapist is only able to visually estimate, rather than objectively measure, the extent of the infant's active neck motion. In both the 2013 and 2018 articles presenting the CMT CPG, the authors describe the inherent difficulty with measuring active range of motion in infants and difficulty isolating a particular active neck motion, noting "…a paucity of practical measurement tools that capture infant movements in the clinical setting in a timely manner" and confirming that most therapists rely on visual estimation [2, 3]. In an examination of a child with CMT, the pediatric physical therapist must hold the infant with two hands under the infant's arms to support the trunk allowing the resulting neck righting motion to occur primarily at the neck as the infant attempts to re-orient the head to an upright position. This assessment technique leaves the therapist with no hands to measure the neck position with a goniometer or other measurement device. In adults, a cervical range of motion (CROM) unit or inclinometer can be placed on the head to provide accurate motion assessment. However, the weight of these units is too much for an infant newly acquiring head control to manage and it is difficult to fit them to a variety of infant head shapes and sizes. Gold-standard analyses include 3-dimensional motion analysis and/or x-ray of the infant's neck and shoulders. Either of these techniques require expensive equipment, time, and expertise making them cost prohibitive and unrealistic for routine assessment. In addition, x-rays would expose an infant to excessive, unnecessary radiation.

A mobile app that can measure torticollis by using the phone's camera and software will be a novel solution to a known, long-standing problem in the physical therapy treatment of CMT. Without objective measurements of head position and tilt, assessment and treatment progression will always be subject to error. By accessing the phone's camera, detecting markers, and creating virtual lines relative to body position, accurate and real-time measurements can be obtained (2 markers on the head, 3 on the trunk). Additionally, due to the inherent nature of the mobile phone, the technology will be readily available to therapist regardless of their practice settings. This will allow accurate, objective measurement of torticollis in the child's natural environment. This app will provide an easy, immediate, and effective means to observe and measure torticollis that will in turn increase the therapist's ability to assess and treat the child with CMT.

4 Methodology

There are two main focus areas of this work, with respect to the problem it is trying to solve. The first is that the angular measurements and respective distances, locations, and rotations of the points of interest are both critically important and difficult to obtain. The second is that working with infants, toddlers, and small children exacerbates that issue because of their difficulties posing, sitting still, or holding positions. Our system works to counter both of these issues by using a real-time tracking system to gather

data. This mobile app-based system is portable and transportable, so it can be used in a variety of locations (rather than just in a clinic). The system utilizes the phone or tablet camera, the IMU, and a coordinated and simplified custom visual tracking system. First, the camera senses its own internal position sensors (gyro or IMU) to determine its relative position to the subject. There is a short orientation procedure that sets this plane of reference and measures the targets for precision tracking. Next, the subject is configured with markers. This can be a color-coded onesie and beanie with built-in markers or small, adhesive patches for smaller kids. Third, the phone is aimed at the subject and it measures the location, size, and configuration of the markers. Finally, the screen image (video of the subject) is augmented with measurements, lines of connections, and angles (Fig. 1 – note: HIPAA regulations disallow pictures with our subjects, so this is the actual overlay on clipart; later we use plates to represent the 5 target locations). These augmented images track the positions in real-time and report any changes. The practitioner can then take 'snapshots' of the measurements for their data or can ask the app to measure maximum and minimum values.

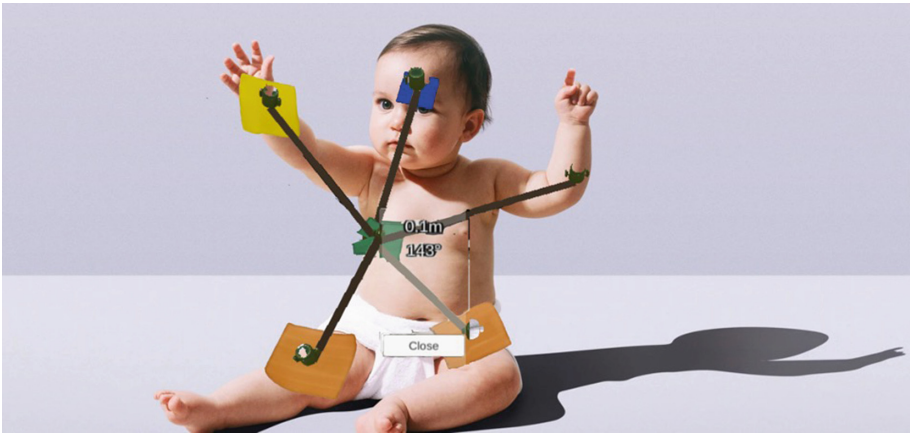

Fig. 1. Alignment with subject

The computer vision is accomplished via an artificial intelligence framework that looks for specific targets and measures their relative size. This is used to create a virtual connected alignment diagram from this data. The targets are specific, so we already know which target is in each location (e.g., the left shoulder is green, center of head is red, etc.). This allows for the augmented image to be overlaid on the video image to show the alignment. The AI toolset then performs measurements by finding the centers of the targets and performing some trigonometry to determine the distance between each marker. By connecting the markers in a particular order (based on their known locations), we can draw lines to show the subject's alignment (Fig. 2, center image). The toolset can then perform additional trigonometry to determine the angles of these lines (Fig. 2, left and right images, neck angle isolations), relative to each other, and report these as the alignment numbers for the study. These angular measurements allow

the clinician to assess the alignment or misalignment of the subject and begin the diagnosis, intervention, or treatment. Further, because the app is user friendly, this same tool can be used by the family of the subject for therapy.

Fig. 2. Neck alignment series

We use delta-based angular measurements (tracking the delta between the initial pose and the current pose) rather than raw angular measurements because of the need to start the measurements from a variety of Castle and Walton-Mouw 6 initial positions. These frames, the virtual analysis, and the derived angular measurements will be recorded to be reviewed later as well. This allows the clinician to review the movements throughout the manipulation to assess the subject. These reviews are available in both real-time and in review so that the clinician can assess, reassess, and make notes based on these findings during the same appointment (rather than having to return later to investigate any concerns). The real-time feedback to the mobile device allows the clinician to see the alignment and movements to make sure that they are recording what is needed. They can also note any change of angles or methods of manipulation that are necessary to ensure proper tracking.

The intention of this system is to decrease cost so that there is a wider-spread ability to utilize it as a common tool for analysis by all practitioners, even those on a limited budget. The software utilized is a customization of an AR tracking system used in robotic control systems. This was done to reduce the overall cost of creating the framework so that it can used and distributed more widely, even for those clinics or practices with smaller budgets. The overall system, the AI-based framework, and the assessment and treatment tools are in their nascent stages, but we are already seeing positive results. In the future, we hope to test the framework with larger sets of subjects. We will continue to develop the system and expand the distribution of the work, taking into consideration the feedback from our studies.

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Applications in Sport and Medicine

FEEDI - A Smart Wearable Foot-Band for Navigation and Guidance Using Haptic Feedback

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Abstract. In this paper, we introduce the design and implementation of a smart foot bracelet for navigation purposes. The foot-band is meant to be worn right above the ankle. FEEDI, as the wearable shall be called, guides pedestrians to their destination by giving them haptic feedback using four vibration motors.

That way, the user's attention is freed from any display and audio feedback, making him perceive more of his surroundings. Furthermore, the wearable could have interesting applications in the medical field. One example is guiding visually impaired individuals or helping people improve their general wellbeing with feedback regarding their physical activities. The band is able to record sensory data from an accelerometer, a gyroscope and a magnetometer. This opens the possibility to use that information for activity monitoring with deep learning methods. All code and further resources are available at https://github.com/Spackelter/FEEDI.

Keywords: Wearables · Navigation · Guidance · 3D printing · Additive manufacturing · Rapid prototyping · Haptic feedback · Tactile feedback · Vibration feedback · Data collection · Pedestrians · Sports

1 Introduction

Over the last decades, smartphones have become perpetual companions to us. They put a huge amount of diverse applications at our permanent disposal. Amongst them, there a lot of navigation apps able to guide us through everyday life. Whether it is to find the closest supermarket or a specific address, to do sightseeing or just to go for a walk, our electronic helpers are always at our side. However, conventional navigation methods have the disadvantage that they require the user to constantly look down at a display. This is not only uncomfortable but can also be distracting from the environment. In situations like in traffic, it can even be dangerous. Korpinen et al. [1] state that mobile phones can cause close call situations and accidents. This paper describes the prototyping process of a foot bracelet, which can guide the user to his destination using haptic feedback. For this purpose, the device contains four vibration motors fixed in the

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front, back and on both sides of the band respectively. As a result, a multitude of directions can be represented by making one or two motors vibrate at the same time with either identical or different intensities. Through a smartphone app, the user can fine tune the haptic feedback and select their destination.

The topic 'navigation using haptic feedback' has been tackled in a variety of different ways. With the idea to follow the trend of smartwatches, Dobbelstein et al. [2] built a wristband including four vibration motors for navigation purposes. In a similar project, Pielot et al. [3] built a belt containing vibration motors. Meier et al. [4] briefly inspected several devices each providing navigation information as haptic feedback to a different body part. They then went on to evaluate shoes fulfilling this task more in detail. Azenkot et al. [5] tested three smartphone-based haptic navigation methods. Amemiya et al. [6, 7] built and enhanced a circular apparatus capable of creating a pseudo-force into one of eight cardinal directions (multiples of 45°). The mentioned papers deemed their respective navigation methods as intuitive and effective. Meier et al. [4] even suggest that providing navigation information through haptic rather than visual feedback can help users decrease their stress level.

To the best of our knowledge, there is currently no published approach based on a foot bracelet like discussed in this paper. This implementation form combines the advantages of other shapes: It is slim, easy to put on, not tied to a specific piece of clothing and the feedback is very intuitive as the motors always face the same direction in respect to the user orientation.

2 Prototyping, Electrical Design and Program Design

The task of constructing the band was split up into multiple challenges. First, a general concept for the navigation process was needed. Building on this, the next step consisted in defining the fundamental functionalities of the band as well as selecting a set of electronic components able to fulfill them. We designed a 3D-printable shell that, at the same time, is slim and able to fit all the necessary electronics. The last task contained the challenges of wire-management and finding a closing mechanism allowing the user to easily put on and take off the band.

Figure 1 describes how the navigation task is executed. Through an app, the user can choose the target location and start the navigation. From that point on, smartphone and foot bracelet co-operate to guide the user towards his target. The phone periodically calculates the user position through GPS as well as the angle between the user and his target in respect to north. The latter is then transmitted via Bluetooth to the foot bracelet, which also calculates the user orientation in respect to north. Thereof, FEEDI calculates the angle between user and target location (see Fig. 1, right). By making one or two motors vibrate at the same time with identical or different intensities, each possible angle between them can be represented. Thus, if the band contains motors which are distributed around the leg, all possible directions can be represented. Using this technique, the band guides the user to his target by periodically vibrating towards it (angle ρ in Fig. 1).

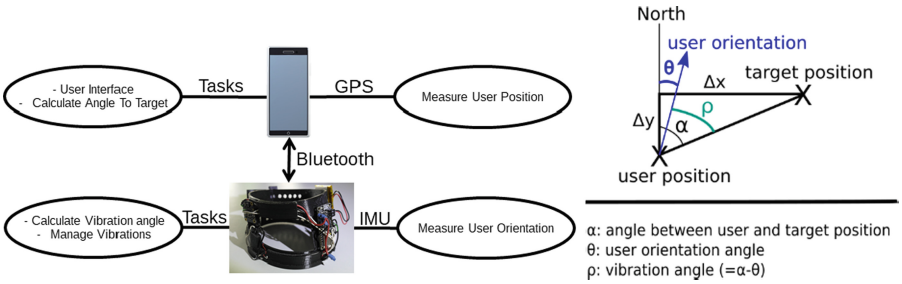


Fig. 1. Functional principle of FEEDI - *Left image*: Overall setup (sensor tasks and general tasks of the devices and communication channel between them) *Right image*: How the vibration angle ρ is calculated.

To fulfill its duties, the band needs a controller, Bluetooth capacities, a magnetometer to calculate the user orientation and vibration motors, which can be controlled individually. As the system needs to know the deflection of the user's leg in order to interpret the magnetometer data correctly, a gyroscope is needed. Therefore, we chose the Adafruit Feather 32u4 BLE as a microcontroller board. It includes Bluetooth capacities and a connector for powering the device using a Li-Po battery (3.7 V, 500 mAh). As an orientation sensor, Bosch's BNO055 IMU has been selected in form of an Adafruit breakout board. In addition to the needed sensors, the BNO055 contains an accelerometer, which can be used for auto-calibration of the user orientation based on Earth's gravitational field. The microcontroller board and the sensor module communicate via I2C. The Adafruit Feather 32u4 BLE also controls the intensities of the vibration motors through PWM. The vibration motors are consuming around 60 mA. However, the maximum output current of the microcontroller's logic pins is only 10 mA. Therefore, the motors are wired directly to its voltage pin (maximum output current: 400 mA) and can be pulled to ground through MOSFETs (see Fig. 2).

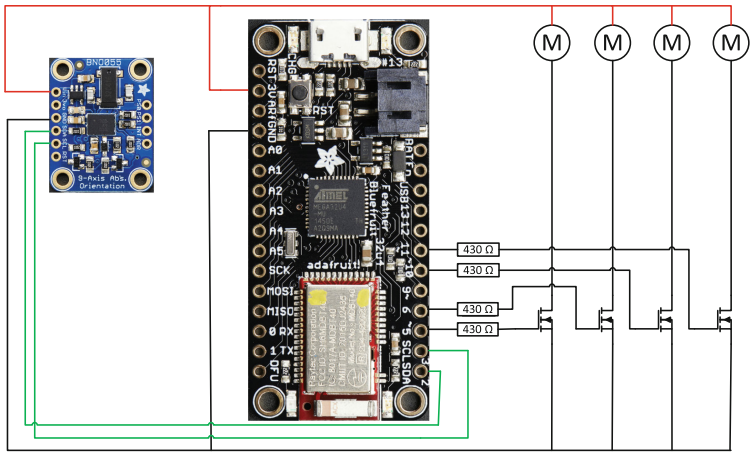


Fig. 2. Wiring diagram of FEEDI using the BNO055 Adafruit breakout board (*left*), the Adafruit Feather 32U4 BLE (*middle*), some 420 Ω resistors, MOS-FETs and vibration motors.

3 User Study – Vibration Perception at the Ankle

A study with 12 participants (4 female, 8 male, aged between 22 and 60 years, average age: 37.7 years, standard deviation: 16.8 years) was conducted to determine the number of vibration motors needed to display the direction of the target with sufficiently high resolution. For this purpose, the 'Vibration Perception Sock' represented in Fig. 3 (left) was built. It contains eight vibration motors arranged as displayed in Fig. 3 (right). As mentioned in the previous section, angles are represented by making one or two motors vibrate at the same time with identical or different intensities (controlled via PWM). As displayed in Fig. 3 (left), a rubber band was put around the sock to ensure that all the vibration motors have skin-contact.

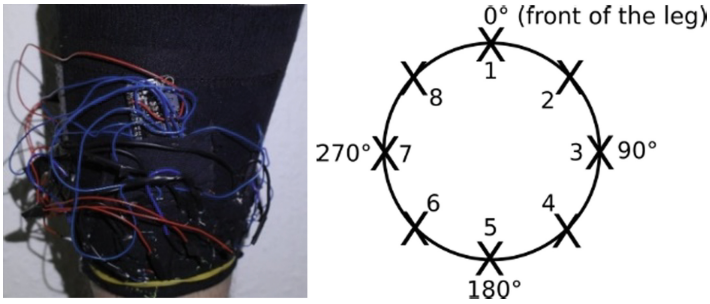


Fig. 3. 'Vibration Perception Sock'-setup. The crosses represent the vibration motor positions.

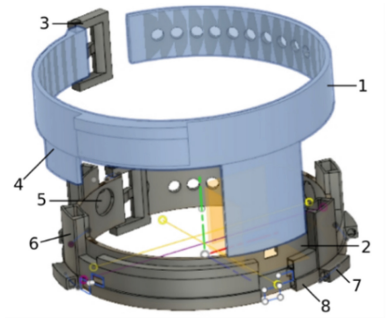
A series of 12 angles was displayed to them using all the 8 built-in motors. The same angles (in a different order to avoid influencing the results) were then displayed using only motors 1, 3, 5 and 7 and, finally, the procedure was repeated using only motors 2, 4, 6 and 8. The subjects were given the task to identify each of the represented angles. As a help, they were provided with a circle annotated with all angles that are integer multiples of 10°. The average value and standard deviation of the angular errors have been calculated for all 3 vibration modes. Furthermore, errors up to 30° have been judged neglectable for the navigation task (since it was deemed that the user only needs to roughly know the direction in which his target is lying) while all 'small' errors between 30° and 45° and 'big' errors above 45° have been counted for each of the vibration modes. The results are summarized in Table 1. As can be seen, the methods do not substantially differ from each other in effectiveness. Using these results, all 3 modes have been deemed adequate. Hence, to minimize wiring efforts, only 4 vibration motors are included in the band. The motors are placed in the front, on the left, on the right and in the back of the band as the test subjects unanimously judged the feedback as less natural when it came only from motors 2, 4, 6 and 8.

Table 1. Results of the 'Vibration Perception Sock' user study

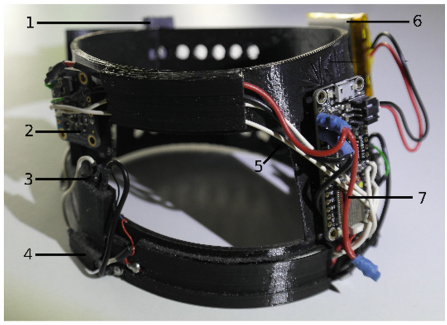
Vibration mode	Average error	Standard deviation	Small errors (>30°, ≤45°)	Big errors (>45°)
(1) All 8 motors	15.8°	15.1°	15/132 (11.4%)	4/132 (3.0%)
(2) Motors 1,3,5 and 7	15.6°	16.6°	12/132 (9.1%)	7/132 (5.3%)
(3) Motors 2,4,6 and 8	15.6°	19.7°	14/132 (10.6%)	9/132 (6.9%)

4 Mechanical Design and Final Implementation

The electronic components of the band were chosen and wired as explained in Sect. 2 (See Fig. 2). The shell of the band was designed using a CAD program and built by an (FDM) 3D-printer. For the device to fit smoothly around the user's leg, the flexible filament PolyFlex™ (by PolyMaker) was chosen as shell material. During the design of the band, a few challenges occurred: The band needed to be as slim as possible, but still able to fit all of the electronic components, the wiring needed to be managed, the components needed to be fixed to the band and an easy-to-use closing mechanism needed to be found. The final design consists of two parts glued together using superglue and is represented in Fig. 4. For wire management purposes, cable channels are included in the design. The electronic components are fixed to the shell using self-adhesive hook-and-loop tape. The closing mechanism is inspired by watch buckles and allows the user to adjust the band's circumference between 26 cm and 33 cm (top part) and between 25 cm and 30 cm (bottom part). The buckle is printed from PLA.



1: top part of the band, 2: bottom part of the band,
3: buckle, 4: space for the BNO055, 5: cavity for a vibration motor,
6: cavity for a MOSFET, 7: cavity for a resistor, 8: cable channel



1: Buckle, 2: Bosch BNO055, 3: MOSFET, 4: Resistor,
5: Vibration Motor, 6: Battery (3.7V, 500mAh),
7: Adafruit Feather 32u4 Bluefruit LE

Fig. 4. Final CAD-design of the 3D-printable shell (*left*) and final prototype (*right*).

5 Evaluation

FEEDI fits the human leg smoothly and can be put on and off easily. Future iterations could involve slimming it down by integrating all of the electronic components onto a single board. The navigation works in an intuitive way.

The band could have further interesting applications. As it provides eyes-free navigation, it could be integrated into a guidance system for visually impaired people (like LIDARSEE, see [10]) or even be enhanced to work as a stand-alone device for that purpose. Some related projects specifically aim to build such a system [6, 7].

FEEDI contains an IMU which could be employed for tracking the user's position if a GPS signal loss occurs (for instance in the case of indoor navigation) as it has been done by Gädeke et al. [8]. Anastasopoulou et al. [9] used a barometer and an accelerometer to implement an effective algorithm for activity monitoring. This shows that, with just one additional sensor, the band's functionalities could be extended to help users track how much they exercise. In today's society, where obesity is an increasing problem, this could be a very helpful feature. Applying machine learning in this context might even allow for a more precise estimation of the user's energy expenditure.

6 Conclusion

We have designed and built a working prototype of a foot-band able to provide its user with navigation information via haptic feedback and thus guide him to his target location. The device is comfortable to wear and performs well. This could be a novel and intuitive concept entailing an improvement of safety and a reduction of stress in pedestrian navigation. Furthermore, the device's functionalities could be extended, enabling it for applications in the medical area. For one thing, as the band provides eyes-free directional feedback, it could be used for the guidance of visually impaired or blind people. Additionally, the sensory data measured by the band could be used for activity monitoring and thus help its users improve their health.

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Human Factors in Interfaces for Rehabilitation-Assistive Exoskeletons: A Critical Review and Research Agenda

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Abstract. Exoskeletons are wearable robots designed to restore or augment human physical abilities and, indirectly, cognitive functions. These devices can be classified based on the sector of application, the body part they are intended to support or enhance, the degree of assistance, and the source which they gather power from. Regardless of such technical features, exoskeletons are usually equipped with Human-Machine Interfaces (HMIs), allowing users to interact with the system, both physically and cognitively. The current paper critically reviews the state of the art of HMIs, and discusses the future challenges concerning Human Factors issues associated with the experience of utilisation of HMIs for wearable assistive exoskeletons in neuromotor rehabilitation settings. An overview of extant types of rehabilitative exoskeletons' HMIs is provided, as well as a discussion on novel user experience research questions posed in light of the recent developments in the field.

Keywords: Exoskeletons · Wearable technologies · Rehabilitation · HMI

1 Introduction

Powered exoskeletons can be defined as robotic exosystems designed to restore or enhance user's physical performance.

These devices can be distinguished according to several descriptive criteria such as application sector (military, industrial, medical), part of the human body they are meant to support (full-body, upper-limbs, lower-limbs), degree of provided assistance (partial, complete), and source of power (motorised actuators, biomechanical energy through spring loads). Currently, the majority of market-ready exoskeletal products [1] are available in the medical field (e.g., HAL® by CYBERDYNE, Indego® by Parker

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Hannifin Corp.), followed by industrial and military use-cases. There are very few consumer exoskeletons available for daily life use.

Besides the above technicalities, exoskeletons are usually equipped with Human-Machine Interfaces (HMIs). HMIs allow for user-exoskeleton interaction, both at the physical and at the cognitive level of analysis.

This paper aims to propose a Human Factors and Ergonomics (HFE) perspective on the current state of HMIs for assistive exoskeletons in neuromotor rehabilitation settings. In this context, both the medical operator and the patient must be considered as users of the exoskeleton. This is because the latter uses the exosystem to perform the rehabilitation training, while the former can monitor information regarding the patient and the task. Hence, interfaces enable four types of interactions, namely operator-exoskeleton, patient-exoskeleton, operator-patient, and operator-exoskeleton-patient.

In the next sections, the existing types of interfaces will be reviewed, along with some HFE issues they may be associated with. Furthermore, future challenges in terms of HMI analysis, design and evaluation, as well as research questions about user experience (UX) will be discussed in light of recent developments in the field.

2 Types of HMIs for Rehabilitation-Assistive Exoskeletons

The topic of HMIs for rehabilitative exoskeletons in literature dates back to 2011 [2]. Here, we propose a distinction between physical (pHMIs) and cognitive (cHMIs) human-machine interfaces.

2.1 Physical HMIs

We define pHMIs (e.g., shoulder straps, waist belt, thigh cuffs, shoe connections) as components that allow to transfer the mechanical power directly from the exoskeleton to the human body. Machine-user physical interfacing occurs through complex human-device dynamics depending on both biological tissues and interface materials properties [3]. Development of pHMIs has been mainly addressed in the field of Physical Ergonomics [4]. Wearing comfort has been especially assessed. This is because poorly designed pHMIs can add rigid constraints to the natural joint kinematics, thus becoming uncomfortable after prolonged use and resulting in pain to the user [5]. However, bottom-up approaches towards the analysis of rehabilitative exoskeletons' pHMIs are still lacking. Participatory UX research, entailing the adoption of both quantitative (questionnaires, surveys) and qualitative (interviews, focus groups) subjective methods, is needed. End-users are, indeed, the primary source of information concerning the experience of using the device. To this regard, tools like the well-accredited *Local Perceived Pressure Method* [6] may prove useful to identify whether discomfort originates from specific body regions which pHMIs are attached to.

2.2 Cognitive HMIs

Furthermore, we propose the distinction between three different types of cognitive HMIs based on their purpose, namely Control (C-HMIs), Feedback (F-HMIs), and

Training (T-HMIs). Table 1 shows an overview of different types of rehabilitative exoskeletons' interfaces.

Table 1. Taxonomy of cognitive HMIs for rehabilitative exoskeletons.

Type	Sub-type	References
C-HMIs		
User Interfaces	*Patient HMI*	
	Smartphone app	[8]
	Wearable interface	[9]
	Touch screen display	[10]
	See-through display glasses	[9]
	Gaze analysis	[11]
	Operator HMI	
	Remote controller	[12]
	Graphical interface	[13]
Muscle-Machine Interface (MMI) Brain-Machine Interface (BMI)	*Electromyographic (EMG) pattern recognition*	[14]
	Electroencephalographic (EEG) pattern recognition	[15]
	Motor imagery	[16]
	Electro-oculography (EOG) pattern recognition	[17]
	Eye saccade	[18]
Hybrid Interface	*MMI-BMI*	
	EEG-EMG based	[19]
F-HMIs		
Therapy Status Visualisations		[7]
Patient Health Monitoring		[7]
T-HMIs		
Brain-Computer Interface		[20]
Virtual Reality-Based Game-Like Interface		[21]
Augmented Reality-Based Interface		[22]
Haptic Interface		[23]

Firstly, C-HMIs allow users to operate the exoskeleton and send commands to the machine so as to perform the tasks it is designed to accomplish. This is not necessarily done by the physician. For instance, lower-limb Ekso GT^{TM} by Ekso Bionics has four buttons placed under the crutch's handle that patients can press to turn on, walk forward and backwards, and stop.

Secondly, F-HMIs [7] provide real-time information through auditory, visual or haptic signals, and allow the operator to monitor task-relevant factors during the

rehabilitation training sessions, such as patient health status, system status and performance indicators. This type of HMIs is particularly useful for keeping track of improvements along the whole rehabilitation process.

Lastly, T-HMIs are meant to guide the patient during the rehabilitation training by placing the user in a stimulating environment.

3 Human Factors Issues

Some contributions to the rehabilitative exoskeletons' interfaces field refer to HFE concepts such as usability [8, 24–27], fatigue [24, 26], user engagement [28, 29], and workload [30, 31]. However, several issues have not been addressed yet.

The first challenge entails C-HMIs. From a user-centred design perspective, controllers for rehabilitative exoskeletons should be straightforward and intuitive in order to minimise perceptual, cognitive, and physical efforts associated with operating the system. An easily comprehensible control interface can improve users' mode awareness [32] and protect them from accidental actuation, misuse, or unintended behaviours. The implementation of a stop-switch is advised to ensure safety in case of system malfunction. Most importantly, C-HMIs should never fail to signal an exoskeleton malfunction, and ought to guarantee performance consistency and reliability, which are significant factors of trust in human-robot collaboration [33]. The failure of a technological device to signal the occurrence of a malfunction is a major concern, since mode awareness is not stimulated, and reactive behaviour is not prompted. Thus, the user will not be able to implement strategies to manage and fix the malfunction. To this regard, performance indicators such as number of error messages from the HMI, number of times safe mode is activated when not needed, and number of times safe mode is not activated when needed, can be valuable metrics to consider, for example, in an observational checklist.

Another issue concerns F-HMIs that can be used by both operator and patient at once. F-HMIs can support situational awareness and the development of a shared mental model concerning the definition of the situation. Hence, F-HMIs may have positive effects on plain communication and mutual understanding between operator and patient and may contribute to clinical compliance and therapy success. Future research should investigate practical solutions to keep optimal levels of shared situational awareness.

Finally, new developments have been recently made in the field of exoskeletons interfaces. Bioelectric signals and Brain-Computer Interfaces [34] stand as the most innovative evolutions of these products. It is essential to consider which research questions are posed by these trends in terms of HMI analysis, design, and UX assessment.

These developments may also redefine the distinction between passive and active exoskeletons. While the engineering perspective on exosystems distinguishes between active and passive exoskeletons based on the presence or absence of motors, the medical viewpoint is based on whether the patient is "the pilot" rather than "the passenger" of the device. A unified definition should be looked for in the future.

4 Conclusions

This paper provided an overview on extant types of HMIs for rehabilitative exoskeletons, as well as on current and future HFE issues they relate to.

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Spontaneous Physical Activity and Sedentary Patterns Analyzed in a General Population of Adults by the eMouve Application

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Abstract. Sedentary behavior and inactivity are behaviors that are associated with obesity. The aim of this study was to classify 109 adult participants of various BMI in different homogeneous clusters on the basis of time spent at four physical activity levels. The cluster analysis tree shows three distinct clusters. The clusters significantly differed in BMI, hip circumference, and time spent in sedentary and active behaviors. The largest difference between clusters dealt with sedentary time: higher in CL2 (13 normal weight and 33 overweight) than in CL1 (33 normal weight and 20 overweight) and CL3 (9 normal weight and 1 overweight). Overweight is also associated with brief time in light- or moderate-intensity activities. However, some normal-weight adults had the same sedentary pattern as obese individuals. Factors other than physical activity or sedentary time might be more directly involved in body weight excess.

Keywords: Sedentary behavior · Physical activity · Overweight · eMouve application · Accelerometry data · Smartphone · Free-living conditions

1 Introduction

Sedentary behavior and the lack of physical activity have prejudicial effects on health status [1]. These behaviors are associated with the development of chronic diseases such as obesity, type 2 diabetes and some cancers, as well as with an increase in the death rate [2]. Sedentary behavior and moderate- and vigorous-intensity activities are usually assessed by physical activity questionnaires. The responses in terms of sitting time or time spent walking are based on the individual's memory. Therefore, these estimations are approximate and sometimes biased. Furthermore, the questionnaires are unable to estimate light-intensity activities such as wandering or brief physical

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activities such as a postural change. These activities were recently recognized to reduce mortality [3]. Physical activity guidelines for adults based on responses to physical activity questionnaires recommend practicing 30 $min.d^{-1}$, five times per week, of moderate or vigorous activities to decrease the death rate [4]. The guidelines do not take the body mass index into account and do not give advice about the duration of light activities or sedentary time.

Since information and communication technologies can be useful for healthcare, we developed an Android application (eMouve) that can be downloaded at the Play Store. This application is dedicated to research projects that quantify the time spent in four activity categories related to their intensity from accelerometry data. The activity intensities are expressed in metabolic task (MET): immobile [0.9–2.0 MET], light [2.0–3.5 MET], moderate [3.5–6 MET], and vigorous intensity [6.0–9.0 MET]. Since the energy cost depends not only on the activity but also on the individual's characteristics (sex, age, weight and height), the MET values were personalized. The algorithms estimated the time spent in each category. They were specifically designed to estimate, on the one hand, the daily-living activities of normal-weight adults and, on the other, the activities of overweight/obese adults in free-living conditions. The algorithms were validated against reference methods commonly used in energy metabolism [5, 6].

In this context, our aim was to determine which type of behavior is associated with body weight. These behaviors were accurately recorded in an adult population of various body mass indices using the eMouve application.

2 Material and Methods

2.1 Participants

One hundred and nine adult volunteers (54 women and 55 men), either normal weight (NW), overweight (OW) or obese (OB), were studied in free-living conditions (Table 1). They were recruited anonymously for the open-door event of an INRA center. Each volunteer was instructed to download the eMouveRecherche application on his/her own smartphone from the Play Store and to then wear the smartphone in the left pants pocket. The participants were told to maintain their current habits for the waking period of at least 1 day, i.e., free and spontaneous activities. Accelerometry data were collected by their smartphones at 6 Hz. The raw accelerometry data were then sent via Internet to the ActivCollector Web platform (https://activcollector.clermont.inra.fr) where they were immediately encrypted, compiled and analyzed according to the algorithms designed in [5, 6]. Thus, accelerometry data were aggregated minute-by-minute and ranked in one of the four levels of physical activity:

immobility, light-, moderate- and vigorous-intensity. The treatment results, i.e., time spent in each activity category expressed in minutes or in percentage during the waking period were available on the Web platform.

Table 1. Characteristics of volunteers.

Variables	Normal weight	Overweight	Obese
Size	55	26	28
Age (y)	39 ± 12	45 ± 12	47 ± 9
BMI ($kg.m^{-2}$)	21.8 ± 1.9	27.5 ± 1.5	34.9 ± 3.5
Waist circumference (cm)	78.5 ± 8.4	99.1 ± 8.7	109.5 ± 8.4

2.2 Statistical Treatments

Each volunteer was classified by applying a cluster analysis to four variables: percentage of time of the waking period spent immobile, in light-, moderate- and vigorous-intensity activity and by using Ward's minimum-variance method (Cluster procedure of SAS). The clustering method is shown with the tree diagram produced by the Tree procedure of SAS. A χ^2 test was performed to compare the proportion of normal weight, overweight and obese individuals in the three clusters (Frequency procedure of SAS). Finally, a one-way analysis of variance was carried out to determine the cluster effect on age, BMI, waist circumference and time spent in immobility, light-, moderate- and vigorous-intensity activity (GLM procedure of SAS). P values of less than 0.05 were regarded as being statistically significant. When the cluster effect was significant, a multiple comparison test for unbalanced data was made (LSMeans procedure of SAS).

3 Results

The mean recording time was 13 h ± 2 hours per day. The mean time spent in sedentary behavior for the waking period was 74% ± 13% (9.5 h ± 2.3 h), broken down as follows: light-intensity activity: 20% ± 11%; moderate-intensity activity: 5.5% ± 4%; and vigorous activity: 0.5% ± 1.2%. The cluster analysis tree shows three distinct clusters (Fig. 1).

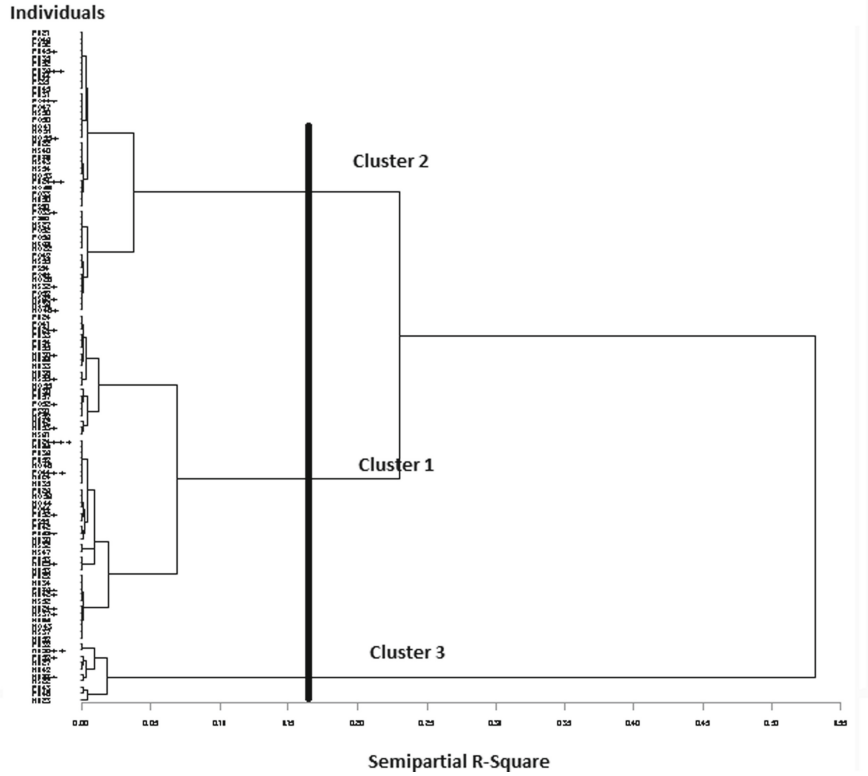

Fig. 1. Cluster analysis tree. This figure shows three clusters of individuals that have different sedentary and active behaviors.

The clusters did not significantly differ in age or in the breakdown of men/women but, instead, in BMI ($F = 11.3$, $p < 0.0001$), waist circumference ($F = 4.8$, $p = 0.01$), and time spent in sedentary behavior: $F = 265.8$, $p < 0.0001$; light: $F = 153.4$, $p < 0.0001$; moderate: $F = 14.4$, $p < 0.0001$; and vigorous: $F = 3.6$, $p = 0.02$, (Table 2). The first cluster (CL1) is composed of 53 adults (33 NW, 11 OW and 9 OB), the second one (CL2) of 46 (13 NW, 14 OW and 19 OB), and the third one (CL3) of 10 (9 NW and 1 OW). The breakdown according to the normal weight, overweight and obese status is different in the three clusters ($\chi^2 = 19.4$, $p = 0.0007$; Table 2). The largest difference between clusters dealt with sedentary time: higher in CL2 (84% of the waking time) vs. 70% (CL1) and 44% (CL3). Conversely, time spent in light activity was lower in CL2 (12.4%) than in CL1 (22.6%) or CL3 (47%). The percentage of time in moderate and vigorous activities was higher in CL1 and CL3 than in CL2. Mean BMI and waist circumference were lower in CL1 (24.9 $kg.m^{-2}$, 89.3 cm) and CL3 (22.3 $kg.m^{-2}$, 82.5 cm) than in CL2 (29.3 $kg.m^{-2}$, 99.1 cm).

Table 2. Individual and behavioral characteristics of the three clusters.

Variables	Cluster 1	Cluster 2	Cluster 3	P value
Sample size	53	46	10	
Age (y)	42 ± 12	44 ± 11	36 ± 13	0.18
BMI ($kg.m^{-2}$)	24.9 ± 4.8a	29.3 ± 6.4b	22.3 ± 2.5a	< 0.0001
Waist circumference (cm)	89.3 ± 15.7a	99.1 ± 16.4b	82.5 ± 5.6a	0.01
Normal weight (%)	62	28	90	0.0007
Overweight (%)	21	30	10	
Obese (%)	17	42	0	
Immobility (%)	70.3 ± 5.5a	84.2 ± 4.3b	44.1 ± 7.2c	< 0.0001
Light (%)	22.6 ± 6.6a	12.4 ± 4.3b	46.9 ± 7.0ac	< 0.0001
Moderate (%)	6.3 ± 4.0a	3.2 ± 1.9b	8.5 a ± 5.6a	< 0.0001
Vigorous (%)	0.8 ± 1.5a	0.2 ± 0.6b	0.5 ± 1.0ab	0.03

Different letters indicate that the means are different.

4 Discussion and Conclusion

The results show large differences in behavior according to the classification. Cluster 3 was the most active: more time was spent in physical activity than in sedentary behavior. The light-intensity activities were favored. This cluster includes a few individuals who are generally normal weight and never obese. Long active time appears to be inconsistent with obesity. In contrast, the mean age of volunteers was not different between the three clusters. In this age range (22–66 years), age is not related to the active or sedentary behaviors. Cluster 1 was active almost 30% of the waking period, i.e., half of the time of cluster 3. In this cluster, 62% of the volunteers were normal weight, while the others were overweight without significant age differences between the three weight statuses (40 y for NW, 44 y for OW and 47 y for OB). Thus, 30% of active time is not a guarantee of normal weight. Cluster 2 was twice less active than cluster 1 and four times less active than cluster 3 (only 16% of active time). This cluster includes a majority of obese individuals and a minority of normal-weight individuals. To be very sedentary (84% of the waking time) did not systematically lead to obesity. Thus, 28% of the individuals in cluster 2 were normal weight. However, these latter individuals were younger (36 y) than both the overweight (47 y) and obese individuals (46 y) ranked in cluster 2. Ekelund et al. hypothesized that the physical activity reduction observed in overweight/obese participants may be due to the heavy weight of the body and the fatigue resulting from moving it [7]. We confirm that overweight and obesity are mainly associated with a high percentage of sedentary time and a brief amount of time in light- or moderate-intensity activities. However, some NW individuals had the same sedentary pattern as OB individuals in CL2. In this case, it is not the excessive weight that limits physical activity but, more likely, other individual characteristics in line with motivation or organization. Thus, 20% of European adults recognize a lack of motivation to be physically active and 42% declare not having the time to practice physical activity [8]. Since these normal-weight sedentary individuals were younger than their obese sedentary counterparts, it is not certain that they will remain slim when they age. Thus, people who are not interested in physical activity are more likely to eat less fruits and vegetables than active individuals [9]. A longitudinal study will be necessary to confirm or refute this hypothesis.

In conclusion, to better understand the origin of BMI maintenance or gain during the aging process, it will be necessary to simultaneously study the quality of food intake, as well as physical and sedentary behaviors over time.

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Quasi-experimental Study of Exertion, Recovery, and Worker Perceptions Related to Passive Upper-Body Exoskeleton Use During Overhead, Low Force Work

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Abstract. This study aimed to identify the effects of an application of a passive upper-body exoskeleton (EXO) during an overhead, low force, simulated task. Participants were volunteer assembly workers, who performed a simulated work task without and with a commercially available EXO. Their heartrate was recorded at different times during the task, as well as their heartrate recovery time. Frequency of participant-initiated rest breaks was documented. The EXO was also assessed for its perceived usefulness and ease of use by the participants. Findings indicated some potential benefits associated with the adoption of this passive exoskeleton model during an overhead, low-force, simulated work task. Heartrate range and recovery time were reduced in a majority of instances. Participants perceived the EXO to be very easy to use and its usefulness to be average or above average for real-world application.

Keywords: Exoskeleton · Ergonomics · Human factors

1 Introduction

Manufacturing and assembly tasks often involve risk factors for musculoskeletal disorders, including awkward postures related to working over shoulder height. Overhead assembly work, i.e., working with hands above shoulder height, is strenuous and a source of strain on the human body's musculature and joints. The upper extremities, back, shoulders, and neck all bear the burden and stress from working in this forced posture. The neck muscles become tense due to the head tilting backward. The shoulder, although very mobile, is not a stable and robust enough joint to withstand sustained extreme postures [1]. A weakened shoulder is furthermore correlated with forearm muscle fatigue and weakened hand grip strength, likely due to the co-activation of the distal arm muscles during gripping, which triggers the shoulder muscles [2]. Common conditions that result in neck or shoulder pain include tension neck syndrome, bursitis, tendinitis, tendon tears, impingement, instability, and arthritis. Any weakening of the shoulder as well as downstream muscles is, therefore, cause for concern in workers involved in tasks requiring sustained hand and upper extremity control in assembly tasks.

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Although overhead work cannot be modified to a neutral configuration in all situations, there is potential to reduce static loading and exertions by means of the emerging exoskeleton (EXO) technology. With recent advancements in this technology, beyond the rehabilitation and military applications that began in the 1960s, there is now potential for industrial application in assembly and manufacturing tasks. This meld of human and robotic elements can provide a practical blend of human flexibility and robotic power enhancement, and has the potential to lessen risk factors for the development of musculoskeletal disorders while increasing productivity [3, 4].

Passive exoskeletons, different from active (powered) exoskeletons, have no electrical power and instead function on springs or tension lines [4]. Passive exoskeletons are promoted for weight re-distribution, energy capture, dampening, and locking. In one study, automotive workers equipped with a passive upper-body exoskeleton performed simulated overhead activities [5]. Workers experienced a 30% increase in productivity and reported less fatigue while wearing the exoskeleton.

Moyon et al. [6] evaluated the use of a passive upper-body exoskeleton in manual overhead finishing tasks (polishing, sanding, coating, and painting). Nine participants had their heartrate monitored to assess the cardiac cost during the tasks with and without the exoskeleton. Results indicated a positive impact on cardiac cost (less taxing) and on physical workload, with users reporting general satisfaction with the passive exoskeleton.

The present study aimed to assessing the impact of a passive upper-body exoskeleton, i.e., EksoBionics' EksoVest, applied to a simulated overhead assembly task, on the users' heartrate, recovery time, i.e., return to baseline heartrate, rest break frequency, i.e., lowering hands, and perceived exertion. Data regarding the exoskeleton's perceived "usefulness" and "ease of use" by the workers was also collected and evaluated.

2 Methods

This quasi-experimental study was performed using a volunteer sample of an assembly worker population. The group was accustomed to overhead assembly tasks where hands are above shoulder or head height. Participant exclusion criteria were: use of medication that could influence heartrate; i.e., medications for blood pressure, asthma, anti-depressants/anxiety, antibiotics, or thyroid, current MSD symptoms of the torso or upper extremities. Participants needed to have at least three rounds of experience with the physical ability testing protocol, specifically the overhead work protocol, to be used in this experiment. The study was approved by the University of Wisconsin – Whitewater Institutional Review Board (IRB).

The study followed a One Group Pretest-Posttest design using a volunteer sample of assembly workers that met the study's criteria. Eight male participants performed an 8-min simulated work task without and with the EXO, a week or more apart. During the task, participants stood upright with elbows flexed no more than 45° as they continuously moved nickel-sized stickers to different locations on a vertical structure (fixed metal ladder) between a range of 68–80 in from the floor. This simulated task

was chosen as a representative way to mimic the low force overhead work performed routinely by this assembly group.

Baseline heartrates were taken in a sitting position, and heartrate readings were logged at minutes 2, 4, 6, and 8 during the overhead task. Recovery times, i.e., time between activity cessation and return to baseline heartrate, were recorded. Frequency of participant-initiated rest breaks during the activity, i.e., hands put down, were also documented.

Heartrate was captured using a Polar H10 chest strap heartrate monitor and supporting Polar Beat computer software. The number of breaks taken (one or more hands lowered below shoulder level) was recorded during the 8-min task with users being encouraged to take breaks as needed.

Three survey questionnaires were administered at various phases during the study to assess the participants' perceptions of exertion, discomfort, EXO usefulness, EXO ease of use, and other factors. EXO usefulness and ease of use questions were adopted from the Technology Acceptance Model (TAM) [7] (Fig. 1).

Fig. 1. Simulated low-force overhead task, conditions 1 and 2

3 Results

Average heartrate (HR) levels were observed to decrease (3–18%) in 5 of 8 participants (64% of the group) when the EXO was worn. However, the differences in the baseline heartrates between days (conditions) one and two appeared to affect the average HRs during exertion as well. Heartrate ranges, maximum HR minus baseline HR, showed that in 6 of 8 participants (75%), the heartrate range decreased by 5–62% when the EXO was worn, indicating a potential reduction in exertion needed to perform the task. An increase was observed in 2 of 8 participants (25%).

Recovery time, as indicated by the time it took for HR to return to its starting baseline, was noted to decrease (shorten) in 5 of 8 participants (63%) during EXO use, while 3 of 8 participants (37%) experienced an increase in recovery time.

Only 3 of 8 participants exhibited a reduction in breaks taken (hands lowered from working position) while wearing the EXO. The remaining five participants either

experienced no change in breaks (3 participants) or an increase in breaks taken (2 participants) while wearing the EXO.

Participants were asked, during their pre-experiment questionnaire, which body parts are most affected during actual overhead work, and later asked again during the experimental work task. There was agreement amongst most body parts identified during actual work and simulated work, suggesting that the simulated task was an appropriate proxy. Participants furthermore agreed or strongly agreed that the simulated work task felt similar to the actual overhead work they routinely perform.

Six questions were used to rate participants' perceptions on the EXO's usefulness during overhead assembly work. The ratings were collected at the end of the 8-min simulated work task with the EXO. Usefulness ratings were between 4 and 5.5 in a 7-point scale, indicating a moderately favorable response.

The participants' perceptions on the EXO's ease of use were gauged using six questions administered at the end of the experimental session with the EXO. Median ratings in a 7-point scale were between 6 and 7, indicating a high to very high favorable perception of the EXO easy of use for overhead assembly work.

4 Discussion

This study aimed at evaluating the effects of a commercially available exoskeleton (EXO) on a simulated low force overhead assembly task. Physical demands on workers were assessed through heartrate levels, heartrate recovery time, and number of voluntary rest breaks taken. Participants' perceptions of EXO's usefulness and ease of use during the low force overhead assembly work were appraised.

Findings indicated that the heartrate range (HR max minus HR baseline) was lowered for 75% of participants when wearing the EXO. Heartrate recovery time was reduced in 63% of instances with the EXO. The same or additional rest breaks were taken by 63% of the participants when wearing the EXO. Based on this limited exposure to the technology, participants rated the usefulness of the EXO as average or above average for real world application. Participants rated the EXO's ease of use very highly demonstrating that users perceived the technology as easy to setup, adjust, and operate. No significant statistical differences were found between the two conditions, which was unsurprising considering the experiment duration and sample size.

The study had some significant limitations of note. It used a small sample size, with eight volunteer participants. Subjects were exposed to a short duration, eight-minute simulated task. A limited range of work height zone was used, and only a single exoskeleton size (medium) was available, which may have offered a less than ideal fit to the workers involved.

In conclusion, the study indicated some potential benefits associated with the adoption of this passive exoskeleton model during an overhead, low-force, simulated work task. Future studies using different exoskeleton models, longer exposure times, and larger sample sizes should allow for a more precise and detailed evaluation of this technology.

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Effect of Cognitive Load with Baby Crying on Postural Stability in Air Force

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Abstract. Postural stability is affected by many physiological and biomechanical aspects as well as cognitive and emotional factors. Postural control may affect a pilot's ability to successfully deal with specific demands in airspace. The purpose of this study is to investigate the effect of cognitive load on postural stability in the Czech Air Force. Eighteen pilots performed two trials of postural stability and a cognitive test between them. In the control group of fifteen pilots, participants were measured twice for postural stability with no cognitive load between them. Postural stability was quantified using force platform measures during quiet standing, and cognitive load was assessed by selected tests for spatial abilities while obstructing listening with a highly stressful recording of a crying baby. This study investigates the oscillations of body posture before and after the cognitive load with and without visual input. In the group of pilots with the cognitive load, an improvement in performance in postural stability was found. In contrast to the control group, postural stability in the pilots with the cognitive load was significantly affected by the cognitive task in the size of the ellipse area of the center of gravity while the participants had a smaller ellipse area of the center of gravity compared with the default situation. Cognitive load reduced body swaying, both with eyes open and eyes closed. The results indicate that cognitive load has an impact on some aspects of balance control, and cognitive load may arouse attentional resources and have a positive effect on individual postural stability.

Keywords: Air force · Baby crying · Cognitive load · Postural stability

1 Introduction

Postural stability is defined as the ability to maintain an upright position. It comes in two forms, static and dynamic. Both static postural stability and dynamic postural stability involve complex processes that require dynamic integration of visual, proprioceptive, and vestibular sensory information [1]. Postural stability is affected by individual physiological and biomechanical characteristics as well as by psychological factors. The psychological factors play an important role in posture and at the same time in choosing the optimal program for maintaining postural stability. At a certain level of attention, balance improves. On the other hand, excessive effort, psychological tension and the fear of not coping with the situation are counterproductive to

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maintaining stability. Mental condition affects muscle tension and thus coordination of movement [2]. During quiet standing, the center of pressure (COP)[1] and center of gravity (COG)[2] parameters of postural stability increases with age and depends on whether the participant's eyes are closed or open [3]. The literature on the effects of physical load on balance performance clearly show that balance is affected by muscle fatigue [4]. But there has been little research clarifying the possible mechanism by which postural control requires improved attentional resources after cognitive exercise.

Postural control is generally accompanied by posture-unrelated cognitive activity. Several studies used a dual task design to investigate the effects of two different types of cognitive tasks on stability [5, 6]. Using a dual-task paradigm, researchers have investigated the attentional demands associated with sensory motor processing for postural control. Even highly practiced tasks such as sitting, standing, and walking require some cognitive processing [7]. Maintaining an upright stance increased reaction time compared with a seated position, indicating that quiet standing tasks required some attention and showing a significant relationship between the difficulty of the postural task and the attentional resources allocated to postural control [8]. To maintain the postural sway of an upright stance when performing dual tasks, attention is divided between sensorimotor and cognitive tasks. The effectiveness of postural control under dual task conditions can be reduced to varying degrees compared to the performance of a single task, depending on the processing requirements for concurrent cognitive processing. This is because the sharing of sources of attention between two functional areas reduces the amount of attention available for postural control [6]. The regularity of COP trajectories is positively related to the amount of attention invested in postural control, but in certain situations an increased internal focus may in fact be detrimental to postural control [9].

2 Methods

2.1 Participants

Eighteen healthy participants, 17 men and 1 woman, aged between 28 and 49 years old, participated voluntarily in this study. The experimental group consisted of pilots of jet airplanes and pilots of transport and combat helicopters. The control group was also composed of flight personnel, 12 men and 3 women. Subjects had currently no self-reported injuries, illnesses or musculoskeletal disorders.

2.2 Equipment

Postural stability was quantified using a dual-plate force platform Nintendo Balance Board which recorded vertical ground reaction forces. Each board contains four transducers which are used to assess force distribution and the resultant movements in COP. The Nintendo Balance Board is validated system which can precisely quantify

[1] COP is defined as the center of distributed total force applied to a supporting surface [10].

[2] COG is the mean location of gravitational force acting on the body [10].

COP and center of gravity COG, important components of standing balance. COP is calculated separately for left (L COP) and right leg (R COP).

2.3 Study Design and Procedure

A repeated measures design was used, in which participants performed two trials of a quiet, upright stance before and after exhaustive cognitive tasks involving a highly stressful recording of a baby crying. Changes in stabilometric parameters (ellipse area mean, mean velocity, distance mean) of the experimental group were compared to those of control participants. In the control group, two postural stability measurements were taken with an 18-min pause between them which was filled by simple sitting.

2.4 Postural Stability Task

Postural control was assessed during the quiet upright stance, from the center of pressure and center of gravity time series obtained before and after the cognitive exercises. During each of the two trials, participants performed two simple tasks on the balance board. These balance tasks were chosen based on their high predicative value and common use in previous literature [11]. These balance tests were – one-minute of quiet standing with eyes open and eyes closed. During each trial the participants were instructed to maintain quiet standing on the boards by putting their feet in the middle of the platforms.

2.5 Cognitive Load

The cognitive load (CL) was represented by cognitive tests of spatial abilities while listening to a highly stressful recording of a baby crying provoking an emotional response that subconsciously affects behavior. For measurement of spatial abilities Test No. 07 - selection of shapes and Test No. 08 - tasks with cubes from the Intelligence Structure Test 2000 R (I-S-T 2000 R) were used [12]. To pass, participants were given seven minutes to complete Test No. 07 and nine minutes for Test No. 08. Participants were instructed how to complete the cognitive tests before measuring time and were given headphones with a loud recording of a baby crying. In short, the potential effect of listening to background sound for performing a cognitive test is that it demands one's attention. The loud sound of a baby crying interferes with primary task performance and makes performing a task more difficult.

2.6 Data Analysis

"Statistica 13" statistical software was used for all analyses. The effect of cognitive load on postural stability was assessed using the Wilcoxon Matched Pairs Test, and a significance level of 0.05 was set for all analyses.

Many different techniques and methods were employed as well. The different quantitative and qualitative variables measured in order to objectify postural control - distance (D), mean velocity (MV), and ellipse area (EA) - of COP and COG are the ones most relevant and commonly used [13]. D quantifies the magnitude of the

two-dimensional shift based on the total distance traveled. It is considered to be a valid outcome measurement in numerous populations and balance conditions – the smaller the distance, the better the postural stability [14]. MV is defined as the average horizontal area covered by the movement of the center (AP and ML direction) of force per second [15]. EA quantifies 90% or 95% of the total area covered in both directions using an ellipse to fit the data, where the smaller the surface is, the better the performance is [16].

3 Results

In the cognitive load group, decreasing tendency of all parameters (D, MV, EA) of COG and COP were observed during the trial with eyes open. In a trial with eyes close, postural stability tended to decrease across all parameters (except D and MV of L COP).

In a trial with eyes open, CL produced a significant difference in EA of COG (decreased by 25%), in D of L COP (decreased by 28%) and in MV of L COP (decreased by 28%). In a second trial, EA of COG also significantly fell (decreased by 29%) (See Tables 1 and 2 for a summary of Wilcoxon Pairs Test results with statistically significant variables). The acute effects of cognitive load were observed across all dependent variables in open eye measurements. In the control group, increasing tendencies were found in the variables of the postural stability task with eyes open: D, MV of COG; all variables of L COP and R COP. In a task with eyes close, all variables of COG, all variables of L COP and D and MV of R COP had an increasing tendency, whereas EA of L COP had a decreasing tendency. However, no significant changes between the first and second postural stability task were found.

Compared to the control group, the group with CL demonstrated a decrease in all variables of COG and COP in the trial with eyes open and a decrease in all parameters except D and MV of L COP, in the test of postural stability with eyes close. Significantly decreased parameters of COG and COP indicate better postural stability, while increasing tendencies may suggest impaired postural control.

Table 1. Summary of Wilcoxon Matched Pairs Test results (P values) for the effects of cognitive load on COG (EO – eyes open; EC – eyes close)

	Wilcoxon Matched Pairs Test (BEFORE_AFTER_COG) Marked tests are significant at p <,05000			
Pair of Variables	Valid N	T	Z	p-value
Distance_EO & Distance_EO	18	56,00000	1,284735	0,198886
MeanVel_EO & MeanVel_EO	18	56,00000	1,284735	0,198886
EllipseArea_EO & EllipseArea_EO	18	31,00000	2,373494	0,017621
Distance_EC & Distance_EC	18	80,00000	0,239527	0,810697
MeanVel_EC & MeanVel_EC	18	80,00000	0,239527	0,810697
EllipseArea_EC & EllipseArea_EC	18	33,00000	2,286394	0,022232

Table 2. Summary of Wilcoxon Matched Pairs Test results (P values) for the effects of cognitive load on L COP (EO – eyes open; EC – eyes close)

Pair of Variables	Wilcoxon Matched Pairs Test (BEFORE_AFTER_LCOP) Marked tests are significant at p <,05000			
	Valid N	T	Z	p-value
Distance_EO & Distance_EO	18	34,00000	2,242843	0,024908
MeanVel_EO & MeanVel_EO	18	34,00000	2,242843	0,024908
EllipseArea_EO & EllipseArea_EO	18	47,00000	1,676689	0,093604
Distance_EC & Distance_EC	18	57,00000	1,241185	0,214538
MeanVel_EC & MeanVel_EC	18	57,00000	1,241185	0,214538
EllipseArea_EC & EllipseArea_EC	18	69,00000	0,718581	0,472400

4 Conclusion

The current study was conducted in order to investigate the effect of cognitive load on postural stability. Human postural stability is affected by many psychological factors such as state of anxiety, state of mind, attention, cognitive task etc. This study tested the theoretical proposition that postural control and cognitive load are related to each other. Eighteen subjects participated, each participant performed two trials of the postural stability with eyes open and eyes close and a cognitive test between them. After CL, participants showed improvement in postural control performance across several variables. In the control group, no significant changes in the variables of postural stability between the first and second measurements were found.

The acute effects of cognitive load varied between parameters, with the most substantial effects evident in EA of COG in the trial with eyes closed. In the trial with eyes open, parameters EA of COG, D and MV of COP also significantly decreased. The ellipse area is considered to be an index of overall postural performance, and a reduction in the area of the ellipse indicates an improvement in postural stability [16]. Sway oscillation was influenced by cognitive load. Cognitive load can arouse attentional resources and improve postural stability during an upright stance. According to the Yerkes-Dodson law, optimum performance is achieved at moderate arousal, especially for tasks that are based on some past experience [17]. Along with existing evidence, these results may facilitate the development of strategies to improve acute postural stability. This study had some limitations. According to previous studies [18], many factors can affect postural sway including the vestibular, somatosensory, and visual systems. However, these factors were not included in this study. Therefore, further studies will be needed to fully understand the relationship between cognitive load and postural stability.

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Healthcare and Medical Applications

Supporting the Arm Ability Training of Stroke Patients by a Social-Humanoid Robot

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Abstract. The number of people affected by stroke increased during the last decades. However, the number of therapists is not large enough to fulfill the demands for specific training for stroke survivors. Within the project E-BRAiN (Evidence-based Robot-Assistance in Neurorehabilitation) we want to develop software that allows a humanoid robot to give instructions to perform and to observe carefully selected exercises, provide feedback and in addition to motivate patients.

Keywords: Social humanoid robot · Human factors · Interaction design · Robot Assistance · Rehabilitation for stroke patients · Arm rehabilitation training

1 Introduction

Currently, robots of different style exist. They are heavily involved in domains like industrial production [12] or healthcare [1]. The reader might know many other application domains. Therefore, we mention only two of them here.

For production lines, robots are very functional. They are constructed or a specific purpose and might have arms like a crane only. They do not look like humans and have no head or eyes. They behave and look like machines. Humans do not have empathy with them. There is no desire to communicate with such robots. However, sometimes robots look like animals play the role of pats. Communication and interaction is especially important for elderly people with dementia [3, 6]. Robots that look like humans are characterized as humanoid robots.

Within our project E-BRAiN (Evidence-based Robot Assistance in Neurorehabilitation), we want to use a humanoid robot to support patients after a stroke with their training aiming to restore brain function.

Platz and Lotze [8] report about the clinical effectiveness of specific exercises. We will provide an overview of the exercises and discuss the digitalization of one of them.

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2 Arm Ability Training (AAT)

The Arm Ability Training was designed to promote manual dexterity recovery for stroke patients who have mild to moderate arm paresis [7]. Platz and Lotze report in [8] about its design, clinical effectiveness, and the neurobiology of the actions. The idea of the AAT goes back to the identification of sensor motoric deficits of stroke survivors in [9] and [10]. Figure 1 provides an overview of the suggested training activities.

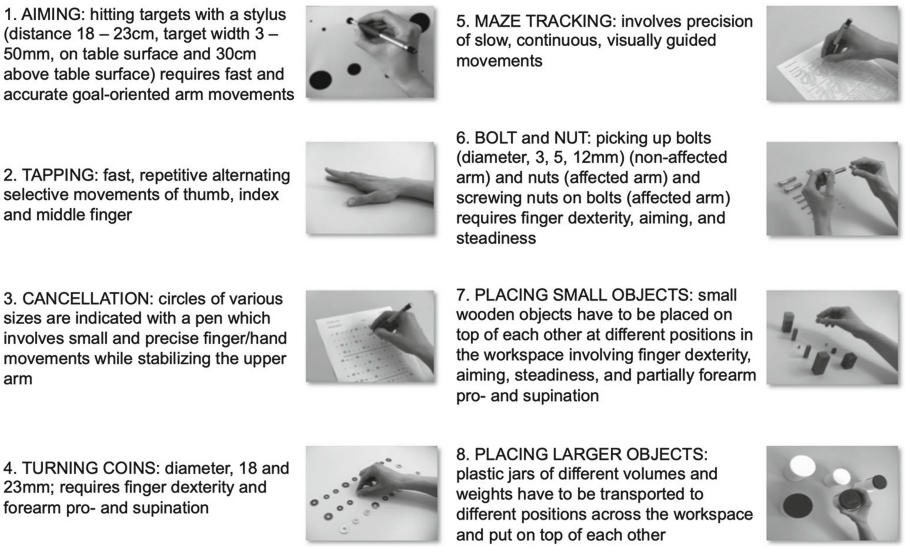

Fig. 1. Training tasks of AAT (from [8]).

The clinical effectiveness of the arm ability training was discussed in [8] on the basis of two single-blind randomized controlled studies (RCT) that included 125 patients who were eligible for the AAT. In one of these two RCT the AAT had superior effectiveness compared to therapeutic time-equivalent "best conventional" therapy.

However, the training is resource intensive because one therapist is necessary to observe and support the exercises of a patient. The idea arose to use a robot for assisting the patients. The robot is intended to lead a stroke survivor through the training and to act as a motivator. It was analyzed which existing kind of robot fits to the requirements of the arm ability training. As a result, the humanoid robot Pepper was selected for first experiments.

3 The Humanoid Robot Pepper

Pepper is a humanoid robot from the company SoftBank Robotics [11]. It is already used in shopping centers, railway stations or airports to give support to customers by providing information (Fig. 2).

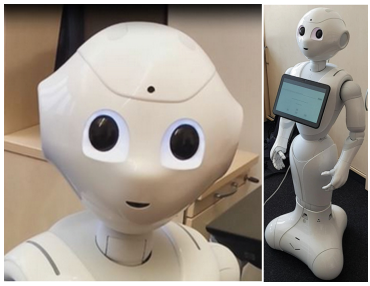

Fig. 2. Humanoid robot pepper from softbanks robotics [11].

Pepper has a very nice facial expression, can talk and move around. The robot can also move its head, blink with eyes and ears. Additionally, Pepper can move its arms and fingers.

We assume that a socially interactive robot can be helpful for stroke survivors when performing their individual training and hence for their recreation. However, the feasibility to use a humanoid robot for neurorehabilitation has yet to be analyzed within an appropriate research setting. Our E-BRAiN project has the objective to implement neurorehabilitation training in a digital form using humanoid robot technology.

4 Challenges in Interaction Design

The design of the interaction of the robot and the patient will likely be a relevant success factor of the application. Among the many questions to be addressed are the following:

- What kind and how much information (e.g. instructions, feedback) has to be provided in which way?
- When should the robot take corrective actions?
- How can the interaction design be modelled in an appropriate way?

Currently, we assume that the arm ability training is introduced by a trained therapist to the patient. The therapist explains all tasks and observes the first executions by the patient. Later, short introductions and the supervision of training sessions are planned to be provided by Pepper. On the tablet upon his chest videos of the task execution can be provided, verbal instructions can be provided via loudspeakers. They can be personalized by clinical assessment and the experience made during a first training session with the “human coach”.

The robot can motivate patients during their exercises with general supporting comments. However, it would be preferable if such comments could be provided related to the shown performance, as feedback. Pepper has a lot of sensors. Nevertheless, it is sometimes difficult to analyze manual tasks performed using paper and pencil. Therefore, a digitalization of training tasks could help a lot to analyze performance and provide feedback. We will demonstrate this by an example of the arm ability training. The respective task is called “hitting targets”. A patient has to hit

circular targets of different size from left to right and afterwards from right to left (see left part of Fig. 3.). Before the next circle can be hit a circle on the table surface ("home position") has to be hit. This can be seen on the right part of Fig. 3. During a pre-specified timespan (1 min) a patient has to hit as many targets as possible. The therapist interrupts the task execution if a target is missed. The patient has to try again to hit that target.

The overall task "hitting targets" (1-min intervals) is repeated four times within a training session. The goal of hitting more targets within the given time span can only be reached when the individual level of performance (i.e. a combination of speed and accuracy) is improved by training, e.g. when speed can be increased without losing accuracy. Patients have to train the tasks at their performance limit and by repetition they will eventually improve their performance in an incremental way (motor learning). In that way they reduce their performance deficits caused by stroke and regain dexterity in everyday life.

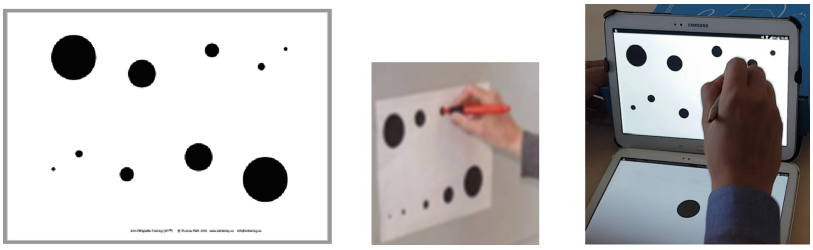

Fig. 3. Manual and digitalized training task.

It was already mentioned that performance of a manual task is difficult to observe by a humanoid robot. Therefore, we implemented an application using two tablets (see Fig. 3 right hand side).

To implement the manual procedure straight away would trigger a comment from Pepper when a target was not hit in a correct way. However, we felt that it would be better if the application on the tablet itself provides an appropriate feedback. In this way the robot could not be perceived as a kind of opponent and the feedback could more directly be linked to task execution and promote movement correction.

We considered the following types of feedback for the task "hitting targets" on the tablet:

- The target that has to be hit next in the sequence is blinking
- A properly hit target becomes green until the next target is properly hit
- A specific acoustic sound is provided for correct and incorrect attempts to hit

In addition, the suggested forms of feedback could be used as redundant information. It will be evaluated in the future which kind of patients would like to have which feedback and when redundant feedback could be clinically warranted. Maybe, some patients might prefer and/or might benefit from the redundant feedback while others might even feel distracted by an "overload" of visuo-acoustic information when

concentrating on their motor performance. As an example, for the former, stroke survivors with visuospatial attentional deficits performing the training might more adequately be supported with multimodal and redundant sensory information, because they have difficulties to orient their attention and hence their movement in visual space.

We are also yet not able to answer the question: "When should the robot take corrective actions?" Experiments with different versions of our application will show which solution is appreciated by patients and which solution does not assist, but puts more pressure on the patients.

5 Summary and Outlook

The paper introduced the arm ability training (AAT) for patients after a stroke. More details can be found in the provided references. Some of these references demonstrate the clinical effectiveness of the training. In addition, it was discussed whether and how a social humanoid robot like Pepper can assist patients during the AAT. Such a robot could play the role of a coach, motivator and supporter. While a humanoid robot cannot and is not intended to replace a human therapist, it might be suitable to support a training situation that might otherwise only be possible in an unsupported patient-led way.

For such a scenario, the AAT itself would need a kind of digitalization. For one training task it was shown how training can be supported based on two tablets and a corresponding application. Solutions for other training tasks will be developed as well.

Because of lack of space, we did not discuss the aspect of modelling of collaborative activities of patients and robots. Some general ideas about the specification of collaborative activities can be found in [2] and [5]. Robot-specific models are discussed in [4]. A comprehensive domain-specific language (DSL) for robot actions will be a challenge for the future.

Evaluation of the success of the digitalized AAT in comparison to conventional AAT with a group of patients are currently planned for the near future.

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Innovation and Technology in One New Hospital in Montreal: A Lived Experience of Healthcare Professionals

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Abstract. In the context of a technological innovation in one new university hospital center (CHU) in Montreal, Canada, the purpose of this study explores the lived experience of the healthcare professionals in this work environment, how the hospital design and some technology attributes facilitate their work and affect their well-being. It is conducted from august to November 2018 in two care units. The analysis includes a phenomenological interpretation of the lived experiences of these professionals following their narratives, observing their environmental behavior. Related to the hospital's size, a linear layout of the care unit, some technological elements in the care units facilitate the healthcare professional's work while others hinder it. The introduction of new technologies and continuous innovation in the hospital work environment must be adapted to the physical context of the hospital in terms of spatial organization and layout of the care unit.

Keywords: Healthcare facilities design · Technology and innovation · Healthcare professionals · Lived experience

1 Introduction

The latest trends in the design of hospital structures show a significant evolution focused on attention to human aspects and the study of the various elements that impact the psychology of the individual who lives in the particular environment of a hospital. The patient-oriented hospital, where humanization means centrality of the person; takes into consideration the requirements of health professionals. Healthcare professionals are constantly confronted with stress in their working environment in hospitals [5]. In a healthcare environment such as a hospital, we cannot ignore the stress experienced by the patient and his or her family, due to their vulnerability and fear of illness and suffering [19, 22]. However, it is important to pay attention to the staff who provide care to these patients [18, 23]. That is why we need to understand the interaction of these professionals with their environment in the contemporary hospital.

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2 A Hospital Is a Stressful Environment for Healthcare Professionals

The healthcare professionals as well as the patient, are confronted to various situations in their work environment in hospitals. They face patient suffering, sometimes also impotence, therapeutic uncertainty and intense workload [5]. Stress causes health problems for the healthcare professionals since it compromises their well-being [14]. Research related to environmental psychology and ergonomics has been conducted in healthcare facilities, with the objective of providing evidence to reduce patient stress, promote healing and well-being [3, 7, 22], the health and well-being of caregivers and their effectiveness [2, 4, 17, 24]. The problem of wayfinding can be a stress factor for patients, visitors and staff [2, 4, 17, 24]. Another attribute of the physical environment that has been proven to reduce stress is a direct contact or through views with nature [8]. Alimoglu and Donmez [1] demonstrated that healthcare professionals who receive 3 h or more of daylight do not have burnout syndrome and are more satisfied with their work environment.

2.1 A Contemporary Hospital - Towards a Less Stressful and Person-Centered Environment

The development of medicine and medical sciences has made it possible to think of the hospital not as voting booth, but as a large facility in the city [15]. Related to the development of medical technologies, social and political development, hospital design has changed significantly over the past century [13]. The hospital has undertaken a transformation in order to mark in the architecture and organization of the space the will to meet the demands of comfort and safety of patients and their families, but also to work for the comfort of the caregiver [16].

Evidence Based Design: Agrowing body of empirical studies shows that the physical environment contributes to improving the quality of care [6, 27] and plays a significant role in the acceptability of treatments and patients' recovery.

The Healing Environment: It is based on the principle that improved clinical outcomes depend on the ability of the healthcare facility environment to contribute to reducing patient stress and promoting patient recovery [21]. Healthcare environments must promote well-being if they are designed to promote: (a) control of the physical-social environment, (b) access to social support, and (c) access to positive distractions. For the access to support it Includes both emotional support and concrete help from those around [21]. Social support allows people to be less stressed and healthier, while those who are socially isolated are more stressed and less healthy [9].

The access to positive distractions reduces the harmful effect of stress [9, 21]. Low or high levels of environmental stimulation can have negative effects on the well-being and health of individuals [9, 22, 27]. Nature has been proven to be a positive distraction factor for patients and staff [22, 26].

The Restorative Environment: The restorative environment approach focuses on the process of attentional recovery (direct or voluntary or intentional, and involuntary or

indirect). The mental fatigue can be negative and represented by irritability, difficulty concentrating, difficulty solving problems, errors and larger accidents [9, 11].

3 Context Setting and Aims of the Research

In recent years, new university hospitals (CHU) have been built in Quebec as a result of the development of medical technologies and with the objective of improving the quality of care. In Montreal, in the 3 recently built university hospitals, new design approaches are integrated, and the physical environment is planned to reduce stress for users and ensure their well-being including the patient-centered design approach. In this context, although attention is focused on users seeking care services, we have less knowledge of how this physical environment is experienced by health professionals [12, 18, 23]. This research examines the issues related to the daily stress of professionals providing care in hospitals, an environment that is becoming increasingly complex. Goals include understanding how the professionals live in their work environment, how the design of contemporary hospitals and some technology attributes facilitate their work and affect their well-being. We delimited our study to the case of the care unit in one of the three newly built CHU in Montreal, in which several innovative and technological elements have been introduced to enable this hospital to provide advanced care such as logistical, medical, human and in collaboration with the health network innovations. These include a new smart computer system to ensure continuity in the replenishment of medical equipment and supplies in the utility rooms of care units, telecommunications infrastructure, the on-call system used in patient rooms and all clinical environments, a pneumatic transport contributing to the functioning of the hospital, and healthcare professional's work, etc. Located in downtown of Montreal, the new CHU is composed of several buildings, including the hospitalization pavilion "D" where are located the care units (8th to 20th floor). This CHU, opened in September 2017, and includes now around 3 741 nurses, 956 physicians, 74 pharmacists, 74 dentists and 2 089 other health professionals such as physiotherapists, nutritionists, etc.

4 Methodology

This exploratory research is conducted in a constructivist approach. It is limited to 2 hospitalization units in one of the major contemporary CHU in Montreal, because of the large size of these hospital. Data collection was conducted throughout the day (3 shifts), every day of the week, including weekends during 3 months from august to November 2018, and we proceeded in stages. First, we observed the physical setting and analyzed this existing environment. Second, we observed health professionals in their work environment to understand their spatial behavior in their work environment in relation to the environmental attributes that existed during the various shifts. During these observations of the spatial behavior of healthcare professionals, we observed, among others, the displacement of these professionals and quantified these movements of 6 healthcare professionals observed in the two care units. In the third step, after

observing the variety of health professionals working in each of the two care units studied, we interviewed 44 participants (physicians, pharmacists, physiotherapists, occupational therapists, nutritionists, nurses and beneficiary attendants) among these professionals. These interviews were completed by the mental map, where we asked these professionals to draw the attributes of the environment, they felt important in the care unit and/or this hospital. The selection of these care units was based on the receptivity of the study by the head-unit managers who welcomed our study and agreed to collaborate in this study by informing the professionals affiliated in their care unit of the extent of our study and its steps. Analysis method are based on a comparative and interpretive approach, for a thorough description of the essence of the lived experience of health professionals. We conducted a phenomenological analysis to reveal the hidden meanings of the description of the experience lived by health professionals at the new CHU [10]. We essentially followed an inductive and synthetic approach. However, we highlighted categories of themes that were subsequently compared with existing data in the scientific literature [12, 20, 25].

5 Results and Discussion

The results of this research identified attributes of the hospital environment that negatively or positively affect the well-being at work, and the work of health professionals. For the shape and volume of the hospital, even if the majority of professionals evaluated the size of the spaces and the connections between the various pavilions as unfavorable elements to facilitate their work and well-being, they consider the hospital as a reference in terms of design and architecture in the greater Montreal area. The hospital with its curtain walls and the height and volume of the building have a symbolism of modernity and renewal with the hospital's architecture in Montreal for most of these professionals. They generally consider their working environment relatively functional but with negative elements in the spaces dedicated to healthcare professionals. The existence of a ceiling lift in patients' rooms and a wheeled lift inside the care unit is a facilitator of professional work and ensures the safety of professionals in terms of workplace accidents, particularly for low back pain.

Related to the linear spatial organization of the care unit with decentralized workstations and the big size of this CHU, some technological elements introduced in the care units constitute a facilitating element of the healthcare professional's work, such as the pneumatic transport, the existence of screens - indicating patient's admission. However, other technological elements hinder the work of these professionals, such as the patient call system, which is not very effective in ensuring quick professionals' responses to patient requests and makes the workstations noisy and stressful. That is also the case of a single telemetry monitor in the care unit which does not facilitate the work of these professionals. In order to reduce stress in their work environment, the healthcare professionals, suggested a whole automated patient record to reduce lose of time searching for patient record and improve their productivity.

An obstacle in the intermediate care area is that health professionals do not have control over all semi-intensive care patients due to the layout of the healthcare unit. They find this spatial configuration of the workstation negative in terms of patient

control. They are always required to check the patient's condition and move between two rooms. However, the ratio of 2 patients only for nurse helps to provide quality patient care. In another part, some equipment and materials used by these professionals are not ergonomic, such as double lockers in clean utility rooms and the layout of workstations (computer workstations) in the main nursing workstation in the north unit, and the concentration of pneumatic transport, storage furniture and lockers behind these computer workstations.

Noise has emerged as a stressful element in this work environment [25] because of some technological elements such as, in the intermediate care area the alarms, which are constantly ringing, are particularly stressful, more for evening and night shift professionals. Participants indicated that compared to the old hospital of this CHU, the sound of each monitor did not go everywhere, and the ring tones of calls are better perceived. The assistant in the old hospital first responded to the patients and then notified the professional through the existing interface in the rooms. But, the noise reduction measures in the environment of the new CHU's care unit use a discreet patient call system insofar as professionals who work with patients or nurses are not alerted by means of an aloud communication system to avoid creating a noise nuisance, but this call system is not very effective because these professionals do not have visual and acoustic control of the environment and take more time to respond to patients' requests. This waiting time can be 7 to 8 min during periods when professionals are busy with another patient and these colleagues cannot meet the patient's request due to the relatively high patient ration contained in the spatial configuration of the care unit. This long waiting time makes ring tones a nuisance for healthcare professionals who are installed in or near nursing workstations. Patients in rooms located near the nursing workstations must feel this noise discomfort, but this study did not measure this element.

Innovations and changes in the practice of care is in permanent installation. Healthcare professionals, in particular, nurses and beneficiary attendants have difficulty keeping up with these permanent changes.

The perception of this work environment has resulted in a mental map as a work environment with ergonomics problems (7% of participants). It shows that the main workstation in the north care unit with functional and ergonomic problems around pneumatic transport, telemetry and computer workstations. With the storage space behind the professionals sitting at the posts, these professionals are disturbed by the professionals who pass behind them to use the storage and or technological equipment.

The adaptability to the physical, technological, social and organizational work environment is a key element of the health professionals' experience at the new university hospital and collegiality within work teams is one of the solutions for adapting to the work environment at the new university hospital.

6 Conclusion

This study contributes to creating a portrait of the actual lived experiences of the healthcare professionals and the methods used bring out issues related to the quality of care experienced by of these healthcare professionals related to the physical

environment and the technology/innovation. The introduction of new technologies and continuous innovation in the hospital work environment extends the period of adaptation of health professionals to their work environment. These innovation and technology must be adapted to the physical context of the hospital in terms of spatial organization and layout of the care unit. We limited our research in one CHU in which we explored only two care units despite its size and the large number of health professionals. The number of participants may be a limitation, but our sample is representative of the fact that a diverse range of types of professionals were recruited in the study. The results of this research can be verified in other care units of this new CHU to see if other results emerge regarding technological attributes and the physical environment from the lived experience of health professionals.

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Service Innovation in Health Care: The Role of Health Platforms as Innovators

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Abstract. The following paper takes a close look at health care platforms, which are promising to enhance the quality of health care systems for a couple of reasons. In order to get a deeper understanding of the services they provide it is necessary to carry out a systematic analysis from a service innovation point of view. That view is extended by a business model perspective and thus creates a holistic picture on how the platforms operate and what benefit they provide for actors within the health care system.

Keywords: Digital transformation · Health care platforms · Service innovation

1 Introduction

Implementing service platforms within the healthcare systems has great potential to increase the quality of a patient's medical treatment by making the process easier and more convenient for all involved stakeholders. Moreover, they can act as important instruments for saving money in the healthcare system. In the face of constantly rising health care system costs in most European states due to eldering societies as wells as the rise of chronical diseases, the pressure is high on handling expenses while simultaneously improve or at least maintain medical treatment standards in ways of availability, affordability and access for all patients [1]. Digitalization is the tool of our time that gives health care systems the chance to face these challenges. If the German health care system would have been working digital, the estimations predicted potential savings up to 34 billion EUR for 2018 alone. This amounts to 12% of the whole budget health care budget that year [2]. Working fully digital in this context means all of the important documents like patient files and prescription are digital available and therefore can easily be shared between doctors, hospitals, nursing homes and the patient. Therefore, quick savings can occur in administrative work and communication between practitioners. Of course, in some European countries this is already the standard procedure.

The present study takes a good look on these health platforms. After identifying and describing them, the central research questions are (1) how do they operate? (2) in what way are they actually innovative and (3) to what degree are platform business models transferable to the health care system?

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Central outcomes of the conducted research will be a systematic overview over established health platforms, their value propositions as well as their degree of service innovation.

2 Platforms and Smart Services

2.1 Definitions

Before further diving into the subject, the central terms must first be clarified in order to create an appropriate understanding for the reader. This paper views platforms as "online entities that serve at least two different sets of users simultaneously, bringing them together and enabling interactions between them that can benefit the users as well as the platform itself […] the distinct sets of users […] interact in at least one direction through the service" [3].

There is another concept, which extends the scope of online platforms describing the whole environment around it. "Digital ecosystems are combinations of interoperating applications, operating systems, platforms, business models and/or hardware, and not all components of the ecosystem must be owned by the same entity […]. Components within digital ecosystems are often linked through data, which may be collected or used differently by each component. Shared use of data within an ecosystem helps it to function better and creates opportunities to expand the ecosystem while engaging customers more deeply" [3].

The first, lean definition of platforms provided the starting point for the screening of health platforms. Digital ecosystems however, have not been explicitly considered in the case selection. The broader definition will prove to be useful in the later evaluation tough.

Moreover, the subject can also be approached from a service point of view, more precisely the perspective of Smart Services. A selection of their central properties in this context are (1) the intensive use of data from physical sensors, users and external sources for service provision [4], (2) combining, storing, processing and analyzing available data on digital platforms [5] as well as (3) the provision of services adapted to the specific context and the individual needs of customers [6]. Depending on the type of smart service, the service bundle comprises digital services and physically performed service elements alike [7]. So very briefly, online platforms and smart services are closely intertwined, whereas platforms provide the digital infrastructure for the development of smart services as well as the implementation of AI within them [8, 9]. Now that the central concepts have been clarified and put into perspective, the question arises regarding the innovative capacity of platforms and the services they provide.

2.2 Types of Service Innovation

Service innovation research has its origin in the analysis of technological innovation for manufacturing and traditionally distinguishes between product and process innovation [10, 11]. The more recent developments in service research however consider more than output and process based innovation and move towards a more holistic

understanding of value creation [12, 13]. This means an extended view of value creation beyond companies, enhancing the role of customers for the creation of value. In a very brief way, the three central dimension on which service value can be created are presented and explained in a simplified form. These will later play an important role in assessing the innovation of the identified platforms.

The first view focuses on service output to generate value. Traditionally, this perspective is based on the assumption that an organization actively provides a service and that the customer assumes the role of the passive consumer. The measurement of output-based innovations consists of quantifiable variables such as the number of services offered, critical success factors for their delivery and performance indicators. Equally important are the success rate and the monetary profitability of the service [14, 15]. It is therefore not surprising that numerous studies on service innovation focus primarily on output [16, 17].

The process view expands the perspective of value creation by addressing the design and flow of service experience as a whole [18]. The focus is clearly on the activity, on how the service is provided. The quantitative dimension of outputs plays a subordinate role. The process view also takes into account the possible impact of the consumer on the value generation, which further distinguishes it from the output-centered view [19]. In addition, the design of a service process offers many possibilities based on the involvement of both consumers and employees. Process innovations can be achieved by increased as well as decreased participation, e.g. in case process steps are fully automated reducing the involvement of employees and consumers [20].

The third view describes the co-creative value generation. It actually brings together two archetypes that have been combined for this purpose. These are the experiential and the systemic type. The former focuses strongly on the experience of a service and considers the emotions triggered by the customer. These experiences generate the true added value of a service and determines the service innovation [13]. The service process itself is only the channel that ensures the provision of the service and does not have an intrinsic value [11]. The latter type describes a systemic approach. It considers all important actors in the market, regulations and institutions in order to finally integrate different resources from different origins. This view is very useful to apply principles of co-creative value creation [20]. Both approaches are based on the assumption that the degree of innovation of the services provided by companies or organizations is greater when understood in the context of a holistic service ecosystem [11].

Now that an understanding of platforms has been generated and different approaches to service innovation have been presented, these concepts will be supplemented by a few more in the following chapter. This is intended to provide a brief overview of the methodological approach of this paper, which will introduce the later analysis.

3 Methodology

This paper will focus on health platforms that are either located at the entry point into the health care system or at the transition from inpatient to outpatient treatment. These points are predestined for platforms because there is a shift between systems that creates many touchpoints between different actors such as patients, practitioners, hospital staff and therapeutic product supplier. With the help of an Internet search, predominantly in the German-speaking area of the Internet, a total of 11 different platforms or services provided via platforms were identified. In order to avoid redundancy a selection of platforms is listed in Table 1.

The systematic comparison of the platforms will be carried out with the help of a category system, based on the central dimensions from Business Model Canvas [21]. The business model canvas is a very helpful tool to examine and compare the functioning of the observed platforms. The central dimensions of Osterwalder used for the following comparison are: Customer segments (in the sense of Business to Business or Business to Customer), value propositions, key resources and key activities. In addition, the type of service innovation is used to evaluate the platforms.

4 Results

All identified platforms make some form of matching and therefore qualify as such per definition. The matched actors are patients, doctors or after-care providers. The customer segments of the platforms are predominantly B2C when entering the healthcare system, B2B(2C) when transitioning from inpatient to outpatient care. Within their respective customer segment, the platform provider show a large overlap in value propositions. Clearly, all of the platforms promise a boost in efficiency, simplifying tasks and thereby reducing time and costs. Accordingly, service innovations are to be classified at the outcome or process level.

With regard to innovation, two providers stand out clearly: EvoCare and Ambulanzpartner. Both support the treatment process by constantly incorporating patient data and supporting curative supervision by digital instruments. That enables patient to co-creatively take part in the value creation and create a positive effect on the possibility of individualized therapy. In order to achieve that, the platforms unite a large number of partners within a network, which makes it even possible to categorize them as digital ecosystems. In addition, it is noticeable that both platforms operate in the aftercare sector.

Table 1. Health care platforms with selection of properties

Name	Customer segment	Value proposition	Type of service innovation
Nubedian	B2B	For hospitals: greater reach in the search for follow-up care providers For follow-up care providers: tailor-made inquiries and transmission of comprehensive patient data	Outcome, process
Etnenos	See above	See above	Outcome, process
Dubidoc	B2C	Minimization of waiting times through digital appointment scheduling	Process
Carie	See above	Patients can be virtually connected to their physician at any time, Doctors can save costs	Process
KYRUUS	See above	Efficient matching of patients and practitioners, online appointment and medical history	Process
Evo Care	B2B2C	Extension of treatment interaction between doctor and patient via digital care processes; Individualized telemedical treatment	Co-creative
Ada	B2C	Information source for quick medical advice; summary of the information important for a diagnosis	Process
Ambulanzpartner	B2B2C	Organizational support, Coordination of the supply of remedies, aids and medications	Outcome, process, Co-creative

5 Implications and Outlook

So far, we saw many platform solutions often offering very similar services. Furthermore, many of them have been operating simultaneously and maintaining different networks, which are rather regionally limited. Still, two of them are clearly standing out. In order to capture a true disruption of the health care system, longitudinal observations will be necessary. These will further reveal the extent to which they will actually maintain their presence in the healthcare market. It is plausible that platforms will join forces in the future to further increase their network effects.

The present study was only a first step to analyse the existing health platforms. It is very promising to build on these findings and to shed more light on the two most innovative providers. What does their business model look like in detail? What partner constellations do they have? Of course, the well-being of the patient should be at the center of attention; this should become the critical point for the further evaluation of the platforms and the services they provide.

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Evaluation of Gerontechnologies: A Support to Decision Making and Prescription

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Abstract. In addition to usual Information and Communication Technology (ICT) devices, things are becoming "therapeutic" and can be dedicated to the specific needs of aging. However, because there is a diversity of senior impairments, one must diagnose needs, expectations, abilities or skills of seniors in order to provide the best adapted functions and usages. Moreover, these devices must be evaluated to determine their real potential and effectiveness. This paper discusses how to choose the best fit between a health technology and age-related deficits, and how we can assess the results of this fit. In this context we will use a tool and methodology called "Design for Adapted Devices" (i.e. DAD). DAD tries to develop adaptable systems based on the comprehensive diagnosis of human deficits and needs taking into account several dimensions of user diversity like skills and abilities (e.g. motor, cognitive skills, etc.), and measure deficits that "modulate users" performances (e.g. social support, experience, strategies, etc.). DAD gives prospective data to define future smart things and provides information about technology assessment.

Keywords: Health Technology Assessment · Universal design · Senior needs · Smart things · Impairments diagnosis · Human-systems integration

1 Introduction

When we talk about seniors, we are talking about a broad category of people who differ in many ways. This may include people who are still active or retired, with or without deficits, living alone or with their families, having the status of caregiver or assisted, living at home or in a retirement home, different in age, etc. This has a generational effect in terms of attitudes, skills, desires, etc. Each of these categories has specific needs.

The accelerated aging of the population reinforced by the lack of medical staff will lead, in the coming years, to an extremely difficult situation when referring to health care system.

In parallel to these two phenomena, a third one related to the "fast development of digital technologies" seems to allow interesting alternatives fulfilling the requirements

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of elderly people, caregivers and professionals. Digital technologies seem to play a key role on some signs of aging by helping, assisting, stimulating and rehabilitating. These new possibilities will improve the quality of life and autonomy of elderly population (i.e. primary users) and increase the capabilities of the professionals or caregivers (i.e. secondary users) for caring, monitoring and diagnosis.

However, these new opportunities have limited success among these two categories of users. Reasons for this are diverse. Manufacturers producing information and communication technologies and those manufacturing technical aids often ignore the needs of these categories of people: those arising from their real perceptual, motor, attention, memory, cognitive and social capacities. The reasons for this are multiple: economic, lack of knowledge about user-center design, lack of research on user feedback and different contexts of use, stereotypes of designers about the elderly and more specifically a lack of information and understanding of people with special needs [1, 2].

There is hence a clear need to diagnose the disabilities and the needs precisely, to find adapted solutions between the technological potentials and the difficulties of people and finally, to evaluate solutions in order to generalize results.

2 Health Technologies – Gerontechnologies and Their Assessment

"Health technology" is a generic term that includes many goods and services that can be extremely different, such as pharmaceuticals, supplies, equipment, medical devices, public health programs, support, management and organizational systems used for prevention, screening, diagnosis, treatment, and rehabilitation [3]. In addition, the shape of these technologies can be varied with more or less sophisticated objects, ranging from fall sensors, to connected pill dispensers, or other geolocation and actimetric technologies, etc.

Within these health technologies, we can distinguish a sub-division: the gerontechnologies. The field of study assigned to it combines research on epidemiological and demographic indicators related to ageing (i.e. increase in life expectancy, prevalence and incidence of diseases, etc.), as well as the design and improvement of health technologies; the objective of which is to compensate for deficits or facilitate the activities of older people.

The gerontechnologies are based on two major areas of research that are constantly and rapidly evolving. On the one hand, the medico-social and paramedical sciences (i.e. medicine, geriatrics, psychology, physiology, biology, etc.), and on the other hand, the more design-oriented sciences (i.e. ergonomics, computing, engineering, architecture, etc.).

The scope of these ageing technologies is extremely diverse (e.g. health, housing and domestic life, mobility and transport, management, leisure, safety, etc.), which further complicates its organization and evaluation possibilities. But the objective is the same, that is, to create a technological environment that respects the needs of older

people by allowing them to integrate into and participate in social life and remain at home as long as possible in health and safety. It is therefore essential to be able to test these devices and to have clear and objective indicators concerning effectiveness, benefits/risks, usability, etc.

However, when trying to evaluate the concrete contributions of these technologies opinions diverge. For example, the Parrot social robot system (i.e. Socially assistive robots: SARs) aims to improve social interactions (i.e. therapists, family network, elderly people with dementia) and to encourage people to engage in physical and cognitive activities. When studying the actual contributions of this technology, the data are contradictory. Some report beneficial results [4, 5], while others are more mixed [6].

It is difficult to obtain reliable information on the real utility of a technology for several reasons:

First, the use of information synthesis such as systematic review and, where possible meta-analysis, are interesting sources for evaluation and selection of one device over another. However, they suffer from two problems: a lack of consensus because methodologies and indicators are too different, making the comparison complex [7], and the difficulty to access to the "grey literature", important in this field (e.g. company reports, assessments by private companies, etc.) because of project confidentiality and fear of industrial spying.

Secondly, publication and over-interpretation biases in the available studies can also be suspected. Indeed, a conflict of interest can legitimately be questioned, either when industry uses private evaluation companies or when researchers must find private funds for their work. Moreover, some authors [8, 9] notes that several surveys have shown significant conflicts of interest in the evaluation of medical systems.

Today, there are structures dedicated to the design and experimentation of products for the elderly. University structures such as senior living-labs, user laboratories, or centers of expertise, and private national or international consulting firms, such as the Health Technology Assessment International (i.e. HTAi) and the International Network of Agencies in Health Technology Assessment (i.e. INAHTA), which collaborate with the WHO [10] and propose to test technologies for ageing. Nevertheless, these actors need validated and standardized methods, approaches and tools to obtain more reliable results that could be generalize.

However, from the point of view of evaluation methods, a number of difficulties can be observed in their implementation. For example, gerontechnologies - even when they claim to be therapeutic - are not considered as medical treatments and they don't need to meet the requirements of regulatory agencies (e.g. Food and Drug Administration or European Medicines Agency, etc.) before being placed on the market; even if Europe, unlike the United States, requires a certificate of conformity ("CE" label) for marketing delivered on the basis of a "technical file" which must contain some clinical data, but these data are not comparable to those required for a drug (i.e. clinical trial). Furthermore, some technologies do not take the name "therapeutic" and thus escape these obligations.

It could then be considered that clinical trials should be a standard for evaluating gerontechnologies and to obtain EBPs; but still, the length and complexity of these methodological mechanisms could be considered as time-consuming and too expensive. For example, the evaluation of "fall sensors" carried out by Lachal [11] in his thesis work is relevant, but it corresponds to a too high human and financial cost (i.e. seven health professionals mobilized and 167 patients over a one-year period at a cost of 337 Keuros).

It is therefore essential to conceive efficient methods and tools that allow a valid and clear assessment of technology.

3 A Methodology and a Tool for Assessing Needs of Seniors and Guide Conception of Gerontechnologies

We have recently developed and validated a computerized diagnostic tool and a method for assessing the needs of seniors and to evaluate technical systems and services for seniors [12, 13]. The tool designed "DAD" (i.e. Design for Adapted Devices) is a computer system (i.e. software) whose objective is to facilitate and standardize diagnostic procedures for people with special needs in loss of autonomy, and to analyze their needs according to the tasks and activities performed in everyday life.

The originality and effectiveness of this method derives from the fact that it allows for simultaneous measurement and integration, the diagnosis of the capacities required to use a system, product or service, and the diagnosis of the person's capacities and deficits. The pairing of these two diagnoses allows for an integrative and proactive approach to develop technical solutions for seniors, as a function of their needs.

The DAD diagnosis grid is made of 10 dimensions. Six dimensions measure deficits (motor skills and physical resistance, **Perceptual abilities,** memory and attention, language, temporo-spatial orientation, reasoning, planning and problem solving), while four dimensions evaluate those factors that modulate performances (e.g. social support, experience with ICT, interest and acceptability en effects of medication on the ICT supported activity, strategies, etc.). Each of these dimensions comprehends subdimensions for further specifications [12]. While making a diagnosis of a person's abilities, "modulating factors" must be evaluated because they could influence in a positive or negative way a person's performance. Each ability or skill is evaluated on a Likert scale from 1 to 5, where 1 means an absence of capacity or ability and 5 that the person retains his or her capacities.

In addition, and to establish which deficit should be compensated or rehabilitate for seniors, experts with the system or with the technical domain are submitted to the same grid, in order to evaluate the skills required to use the ICT device or service for activities in everyday life. The gap between a person's assessment and the expert assessment provides what needs to be improved (1) (Fig. 1).

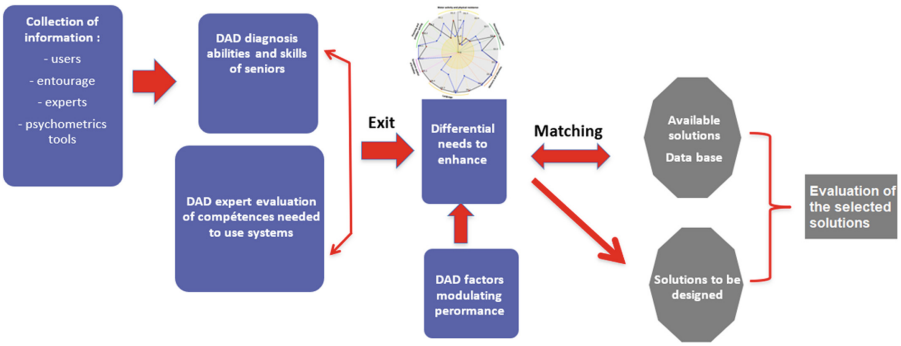

Fig. 1. Design for adapted devices method for evaluating deficits and needs of seniors and for providing adapted solutions

DAD has been designed in a multidisciplinary approach and has been evaluated by geriatricians, doctors, psychologists, ergonomists, nurses, etc. It allows evaluating the capacities of an individual at a time "and their evolution, the creation of population profiles in certain structures, as retirement homes, and to assess the skills needed to use assistive technologies. DAD allows the results obtained to be presented in the form of a statistical table or in a graphical radar chart format, which permits to visualize directly the deficits to be compensated (see Fig. 2).

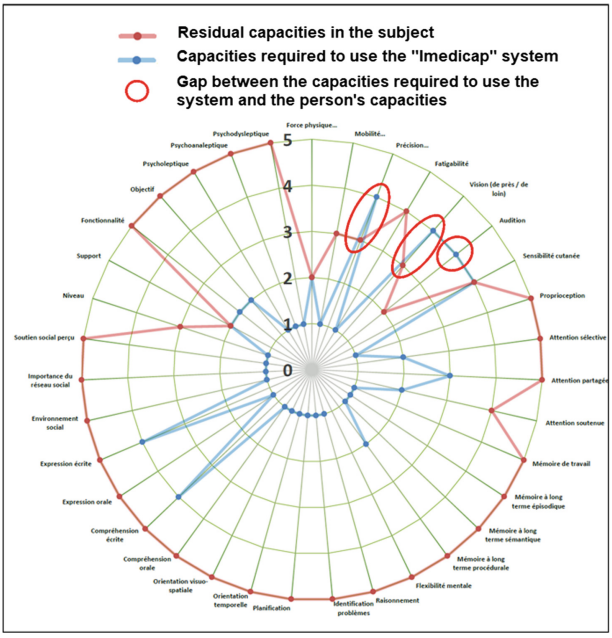

Fig. 2. Differential result between the abilities preserved or deficient in a person and abilities required for using a technical device (pill dispenser "Imedipac")

As we have said before, DAD makes it possible to carry out multiple analyses and compare the adequacy between the residual capacities of people and the systems proposed; or to compare the adequacy of several technical systems intended to provide the same functionalities.

4 Conclusion

Several reports have pointed out important barriers to development, acquisition, use and acceptance of technical aids for seniors with impairments. Among these, lack of information about needs of users, equipment reliability, the need to strengthen monitoring and evaluation of aids proposed, the need for a global and personalized approach to assist seniors, etc. Most of these barriers reflect shortcomings in ergonomics aspects of tools but also the absence of a coordinated, coherent approach to develop aids. Often this is due to intervention of multiples partners who do not share the same frames, references and Knowledge.

Among others, one main purpose of DAD is to propose a standardized tool for helping practitioners concerned ergonomics field that have insufficient knowledge and methods for carrying out this process.

Providing solutions is figuring out how to adapt ICT technologies to the seniors' profiles. In terms of innovative solutions, since DAD was defining the users' requirement profile, a module configuration that you can enable/disable can optimize the adaptation of the interface of the ICT technology to each senior.

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The Wide Area Virtual Environment - A Novel Immersive Environment for Medical Team Training

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Abstract. Medical simulation presents a viable alternative to traditional methods of medical instruction, such as cadavers and animal models. Simulation can provide safe, consistent, and repeatable learning opportunities. It accomplishes this without risk to patient safety. There is an increasing awareness of the value that simulation brings to learning. The Wide Area Virtual Environment (WAVE) is an 8,000 sq. ft. immersive virtual reality facility intended to support medical team instruction. It is the world's largest immersive virtual environment. The WAVE represents a novel application of human-computer interaction. It forms the basis for a synergistic amalgamation of live, virtual, and constructive simulation for medical instruction. This paper describes the motivation behind the WAVE. We also describe the WAVE's primary components, and how they are used during a learning scenario. Our experience with using the WAVE is also described.

Keywords: Immersive reality · Medical simulation · Medical team training

1 Introduction

Simulation is an established component of modern medical instruction. Medical simulation modalities can be broadly divided into three categories: part task trainers, standardized patients, and virtual-reality trainers. Part task trainers are designed to facilitate the practice of specific medical or surgical skills. Standardized patients are trained individuals who have been taught to exhibit the characteristics of real patients. Standardized patients can be deployed in settings where patient examinations must be taught. Virtual-reality trainers present computer-generated scenarios geared toward developing cognitive and dexterous skills. These scenarios can include situations that would otherwise present injury or damage to standardized patients or human patient simulators. An example would be performing a laparotomy.

The Wide Area Virtual Environment (WAVE) is an 8,000 sq. ft. facility designed to present an immersive virtual environment for medical team training. The WAVE is a novel learning platform. It integrates all three simulation modalities to present a unique setting for medical team learning. In the next section, we describe the motivation for developing the WAVE.

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2 Background

The practice of medicine requires knowledge, skills, and experience. Knowledge can be acquired through classroom learning, but skill and experience require practice. The apprenticeship model continues to play a significant role in medical education. [1]. Learners study under experienced practitioners and assist in treatment. This model has disadvantages. The risk to patients from inexperienced learners can be high. This instructional model can be considered as opportunistic learning. The student practices on whatever patient comes into the clinic. Common cases receive more exposure while rare cases may not be studied at all.

To reduce the risk of harm, cadavers and animal models substituted for live patients. While an improvement over practicing on live patients, they have disadvantages. Cadavers can be difficult to procure and do not have a viable physiology. Animals cannot fully replicate human anatomy. Their use also raises ethical concerns.

Modern medical simulation addresses many of these limitations. Three main categories of simulations are in common use: part task trainers, standardized patients, and virtual-reality trainers.

Part task trainers permit learners to focus on practicing specific medical skills. E.g., performing a cricothyroidotomy [2]. Because of their specificity, part task trainers often do not incorporate the full anatomy. The physiological effects of treatment are usually not simulated. Human patient simulators (HPS) evolved to address this shortcoming. HPS are computer-controlled mannequins instrumented to exhibit physiological responses. For example, they can breathe, have a detectable heartbeat and pulse, speak, and have pupils that respond to light. Many of them are self-contained, and incorporate battery packs and wireless data interfaces to allow remote operation.

Standardized patients (SP) are individuals recruited and trained to exhibit characteristics consistent with a live patient. Standardized patients are often used to facilitate medical instruction in a clinical setting. For example, they are used to educate clinicians on the appropriate techniques to examine a patient, and to conduct medical interviews. Standardized patients can also be moulaged to simulate the appearance of traumatic injuries. Thus, they can also be used for rehearsing triage in a mass casualty scenario.

Unlike part-task trainers and standardized patients, virtual reality trainers generally do not use a physical representation of the patient. Instead, learners interact with a virtual human within a computer system. Depending on the application, tactile senses can be replicated using haptic interface devices [3] while 3D displays provide the illusion of depth. The Haptic Workbench [4] is an example of a virtual trainer with medical applications (e.g. [5]).

Despite their individual success, there has been few attempts to combine modalities. [6] described using an HPS within a CAVE environment. [7] incorporated virtual avatars that serve as guides to the learner within a surgical environment. Integration was done at a small scale, and only involved two of the three modalities. Frequently, these attempts provided instruction only to a single learner. Limited effort has been made to integrate all three modalities for medical team instruction.

The WAVE addresses these shortcomings. It combines live action (standardized patients), part task trainers, and immersive virtual environments for medical team training in arbitrary settings that can last several hours. This is discussed in the next section.

3 Methods

The WAVE is an immersive virtual reality theater for medical team training. The WAVE seeks to combine all three modalities commonly used in medical simulation. In this section, we describe the layout, operation, and design of the WAVE.

3.1 Layout

The WAVE is comprised of 24 screens forming two circular pods connected by a corridor. Each pod is approximately 25 ft. in diameter. The corridor is 20 ft long. The corridor tapers from 12 ft. at each end to 9 ft. in the middle. Within the WAVE, learners wear lightweight passive stereo glasses. They perceive an immersive and immersive 3D virtual environment while moving freely within the space. During a training exercise, the WAVE incorporates standardized patients, part task trainers, and lightweight props to simulate actual environments where a medical team can be deployed. E.g., combat or civilian mass-casualty, natural disaster, and chemical/biological/nuclear scenarios. Access to the WAVE is via an entrance in each pod. Each entrance is made up of two screens pivoted to swing outward. During use, they are closed to present a seamless environment. Figure 1 illustrates.

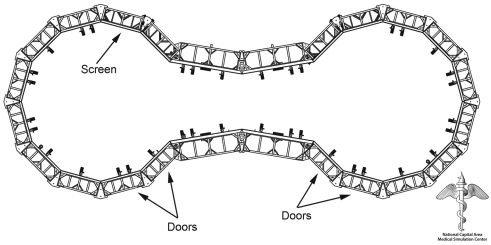

Fig. 1. WAVE layout

3.2 Concept of Operation

The WAVE is designed to support training activities lasting many hours. The nature and scope of the environment changes as the scenario progresses. This is accomplished by changing both virtual and physical environmental elements. Each pod is used alternately as training progresses. The unoccupied pod undergoes reconfiguration in anticipation of the next step in the exercise. A hypothetical scenario is described.

In this example, learners enter Pod A (left) to rescue injured warfighters. The wounded may be portrayed by SPs or HPS, depending on training objectives. As the

injured are treated, the team encounter hostile fire from virtual enemies. They respond by returning fire while the medic performs first aid. The team repels the attack and calls for air evacuation.

While learners are engaged in Pod A, Pod B (right) is being prepared for the next step of the scenario. A mobile motion platform is setup in Pod B with a mockup of a UH-60 helicopter. As the medical team in Pod A prepares the patients for transport, the center curtain lifts. The team physically transports and loads the patients into the UH-60. The scenario continues into the air evacuation phase of the exercise. The medical team provides care while inflight. The WAVE generates imagery consistent with helicopter flight while the motion platform matches the visualized flight characteristics.

During this time, Pod A is reconfigured so it no longer depicts the IED attack scene. Physical props such as road barriers and debris are removed and the visual imagery is changed. Medical equipment consistent with that used in a forward operating base is moved in and a 3D virtual field hospital, complete with animated avatars and sound effects is rendered in the WAVE. By the time the UH-60 lands, learners moving back into Pod A see a completely different scene. This process of alternating between pods during an ongoing scenario allows training to continue indefinitely.

3.3 Visual and Audio Rendering

The WAVE uses an array of back-projected screens to generate 3D stereoscopic images. The display components are modular. Each module consists of a screen, a pair of projectors, and a pair of image generators. Each screen is back-projected by two 15,000 ANSI lumens projectors. Light from each projector is circularly polarized to facilitate 3D viewing. To optimize space usage, projectors are mounted above the screen and pointing backwards. A large, front-silvered mirror in the rear reflects projected light back to the screen. Figure 2 illustrates. Each projector is driven by one image generator. It comprises of a commercial off-the-shelf computer with a consumer graphics card (NVidia GTX 1080 at the time of writing). The WAVE is assembled from 24 display modules: 10 in each pod and four in the corridor. Screens serving as doors are hinged. They are also supported by wheels to facilitate movement. Wheel positions are indexed relative to the floor to ensure consistent screen positioning.

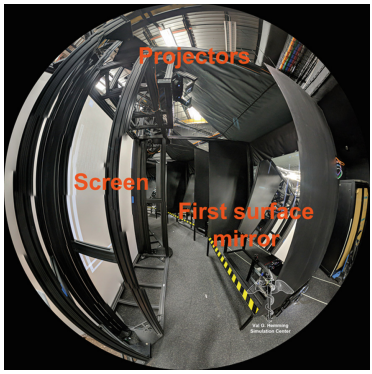

Fig. 2. WAVE module

Audio rendering enhances the realism of the immersive display. Sound effects consistent with the training scenario is generated during training. Audio rendering in each pod is accomplished by a seven-speaker system arranged in a ring above the display modules. Both ambient and directional sounds can be rendered. In addition, a 3 Kw subwoofer is positioned above each pod and above the center of the corridor. These speakers provide subsonic effects. E.g., the percussive effects of a nearby explosion.

4 Results

The WAVE has been in continuous operation since 2012. The WAVE supports the Uniformed Services University of the Health Sciences. It also supports the training requirements of regional military and federal emergency response teams. Smaller systems, termed WAVElets, have been deployed by the Army, Air Force, and Navy. Numerous military as well as civilian emergency response scenarios have been developed. Examples include: Point of injury (military and civilian), chemical release (military), improvised explosive devices, vehicular mass casualty, active shooter, and chemical agent release in public venues.

Figure 3 (left) illustrates a vehicular mass casualty scenario. Multiple injured victims are depicted by standardized patients. The WAVE depicts a much larger casualty field. The noise of emergency vehicles and the cries of the injured deliberately add to the noise and confusion consistent with such a scenario. Figure 3 (right) depict a Forward Surgical Base (FSB) scenario. Here, a medical team works on a human patient simulator configured to simulate blast injuries to the lower body. The WAVE generates an environment consistent with an FSB. Virtual characters depict other medical teams treating additional injured patients.

Fig. 3. Civilian (left) and military (right) WAVE scenarios.

5 Discussion

There are three broad categories of medical simulation: Part task trainers, standardized patients, and virtual reality trainers. These modalities are generally used in isolation. In contrast, the WAVE combines all three modalities in a tightly integrated approach. The WAVE is uniquely suited for capstone exercises, i.e., training events requiring learners to apply everything learned during the course under realistic, often stressful conditions. Unlike field exercises, the WAVE delivers exercises that are more flexible and at a lower cost. Since the WAVE is a controlled environment, exercises can be halted, repeated, or re-started at arbitrary points as required. This capability improves learning by allowing the team to focus on shortcomings discovered in real-time. The WAVE is also well suited for mission specific training. E.g., in hostage rescue situations where familiarity with a specific setting may be critical to success.

6 Conclusion

The WAVE is a novel simulation platform for medical team training. It combines the three primary modalities of medical simulation to produce a unique learning environment. The WAVE's twin-pod configuration facilitates training exercises of an indefinite duration. The WAVE well suited for training specialized medical teams in difficult to replicate scenarios.

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Early Detection of Foodborne Illnesses in Social Media

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Abstract. Alert Center is a platform aiming at detecting outbreaks caused by food toxin infections and food intoxications in Switzerland. It does this by analyzing tweets and sending alerts to the Federal Food Safety and Veterinary Office (FSVO) when a risk is detected. The platform is composed of four main parts: a real-time extractor that targets tweets based on a list of curated keywords, three classifiers (one for each main spoken language) that isolate tweets related to food toxin, a system that locates tweets on the Swiss territory and a web-based dashboard to visualize the results. Combining localization algorithms of tweets and users allows the system to locate 75.09% of the tweets, 2.31% of which were located in Switerzland. In addition, a list of Swiss Twitter accounts corresponding to 15% of the total estimated number of Swiss accounts has been created.

Keywords: Data analysis · Localization · Classification · Risk assessment · Twitter · Food outbreaks detection

1 Introduction

Food toxins infections and food intoxications, in general, can cause outbreaks. If we could prevent these outbreaks, we could avoid health risks for the population, reduce health costs and save a lot of money for companies that have to pay the salaries of their employees in recovery. In Switzerland, the Food Safety and Veterinary Office [1] is responsible for assessing the risks and taking measures to combat the spread of these epidemics. The current system for learning about a risk takes time. Sick citizens usually go to see their doctor after a few days of illness, considering that they are not just waiting for the disease to pass. Cases of poisoning are then reported to the cantonal doctor, who will himself notify the FSVO. The whole process can take from a few days to one or two weeks! The effect of the measures taken at that time is therefore relative. Indeed, sick people will probably already be cured at best, and an epidemic will turn into a pandemic at worst.

Nowadays some people tend to share details about their personal life on the internet and specifically on social networks. If that is the case, it is, therefore, possible that some of them may share the fact that they are sick for some reason. These reasons could be the consumption of poisoned or rotten food, purchased in a store or restaurant for

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example. If this is the case, it should be possible to retrieve this information by analyzing social networks, to find the information directly at the source.

The Twitter social network was chosen to carry out the experiments. Several reasons have confirmed this choice, including the fact that the data are public, unlike other social networks at the moment, and the fact that the data collection is easy and in real-time.

1.1 Challenges

This project brings different challenges. Indeed, Switzerland is a small country with currently about 8.5 million people. To make the detection even harder, four different languages are used (German, French, Italian, and Romansh), not to mention English. Twitter is also not widely used in the country and most of its use is for political or media reasons. The number of Swiss Twitter users as of January 2019 is approximately 765'000 [2].

1.2 Case Study

To validate our hypotheses and assess the feasibility of such a project, a case study was conducted. An outbreak of gastroenteritis due to water contamination infecting about 1200 people raged in the Le Locle area in July 2015. This represented almost 10% of the local population. Tweets published during this period were collected and analyzed to determine if it was possible to detect the epidemic. The results showed a correlation between the number of tweets mentioning symptoms and the reported cases. 9 tweets were concerned. These pre-results gave the green light to continue the research [3].

2 Methods

The platform is composed of four main components: the tweets extractor, the localization system, the classifier, and the visualization, as seen in Fig. 1. The four parts are explained in detail in the following sections.

2.1 Tweet Extractor

The role of this extractor is to collect in real-time the tweets that are published on Twitter. A list of keywords has been defined by the FSVO. This list is divided into three categories: reasons, impacts, and locations. The use of these words, alone or in combination, can identify intoxications. These expressions contain words from standard language but also from colloquial language to fit regional expressions. There are about 90 words per language, and three languages (German, French and Italian).

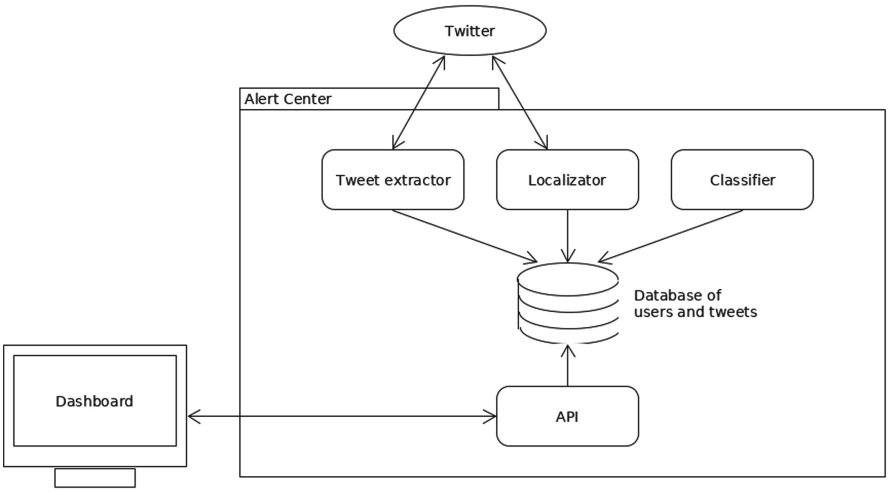

Fig. 1. The architecture of the Alert Center platform

2.2 Localization

Each tweet will be processed by the localizator and the classifier independently. The purpose of the localizator is to determine where a tweet has been published. To do this, several algorithms [4] are applied on the tweet and on the user who published the tweet. Different granularities are possible, from the country to the exact GPS coordinate, via the canton or city precision level. The most consistent and accurate location will then be chosen.

To locate a tweet, the first thing considered is whether the tweet was geolocated when it was published. This is rarely the case, but when it is, it is very useful. If a link is contained in the tweet, the extension will be analyzed, for example, ".ch" corresponds to Switzerland, ".de" to Germany. And then the GeoNames database [5] is used to detect the names of cities, cantons and countries (in different languages) contained in hashtags and tweet plain text [6].

In order to locate users, two pieces of information are taken into account: the "location" and "website" fields that the user indicates in his profile. The techniques of URL country extension and place names are used, as for tweets.

2.3 Classification

The purpose of the classification is to separate tweets that talk about food poisoning from tweets that have nothing to do with the subject. The majority of the tweets collected are unrelated and considered irrelevant. It is, therefore, a binary classification: relevant and not relevant. The classifier used is a simple SVM with a linear kernel whose input features are occurrences of the words used in the tweets weighted using the TF-IDF method. Only the textual content of the tweets are used as features [7].

To keep the performance while limiting the need for training data, it was chosen to have one classifier per language, which gives us 3 classifiers to train (German, French and Italian).

The training data comes from a manual sorting of the collected tweets. Faced with the difficulty of the task, it was decided to add manually created relevant tweets to the dataset. To do this, an online questionnaire asking people to create 10 fake tweets was distributed to some Swiss schools and institutions. Each handmade tweet was then double-checked to ensure relevance.

2.4 Visualization

The visualization was done with web technologies. It is a dashboard designed with HTML/CSS and Vue.js that makes data easy to interpret and interactive with graphics and maps. The data is loaded on the interface through a REST API. Alerts are sent by email to FSVO managers when a threshold of relevant and Swiss tweets is exceeded for a day, allowing them to consult the dashboard to learn more and investigate the potential risk of an epidemic. A weekly email summarizes the events that occurred during the week.

3 Results

In terms of the real-time tweets extractor, the 90 or so keywords per language allow us to retrieve an average of 57,929 tweets per day. The breakdown of languages is as follows: 61.82% for French, 20.2% for Italian and 17.98% for German.

Each tweet will first be localized with the four algorithms (GPS coordinates, places in the text, hashtag place, URLs). The success rates for these algorithms are as follows:

- 14.51% of the tweets have GPS coordinates
- 42.44% of the tweets contain a place name in the raw text
- 1.29% of the tweets contain a place name in a hashtag
- 4.22% of the tweets contain a URL with a country extension

When we collect a tweet, we also retrieve the account of the user who wrote the tweet as well as the accounts of the users cited in that tweet, if any. By combining the 4 tweets localization algorithms and the two ways to localize users for authors and mentioned users, we can define a localization with a certain degree of accuracy. The algorithm that most accurately localizes wins. Here are the results that allow us to locate 75.09% of tweets:

- 14.51% of the tweets with GPS coordinates
- 18.65% of the tweets with a place name in the raw text
- 1% of the tweets with a hashtag
- 1.31% of the tweets with a URL
- 24.36% of the tweets with the location of their author
- 15.26% of the tweets with the location of a user mentioned in it

So the percentage of unlocalized tweets is 24.91%. It must be understood that location information is only an indication. We cannot be sure, for example, that a user lives close to a person he mentions.

Among all the tweets localized, what is of interest for the current project are the tweets posted in Switzerland. The percentage of tweets located in Switzerland is 1.74% of all the tweets collected, and 2.31% of the tweets localized with our technique.

Let's move on to the classifiers part. To have enough training data, we have crowdsourced the creation of fake tweets. This process is still ongoing and will allow us to collect enough tweets. For the moment we have a few hundred tweets, which is not enough to have significant results yet. We achieve classification results between 75% and 90%.

In order to speed up the process of locating Swiss users, we have developed a system to collect potential Swiss users in advance and preprocess them. To do this, we have defined the notion of a "Swiss influencer" as an account followed by an audience of mostly Swiss people. For example, local sports clubs, politicians or regional media. We have therefore compiled a list of 785 such accounts. This list is available on Github[1] [8]. We then collected one by one all the followers of each influencer, tried to locate them thanks to the "place" field and saved in the database only the Swiss users. So when a new tweet is detected, we won't necessarily need to look for information about its author because it will probably already be in our database. As of now, we were able to collect 120'000 self-proclaimed Swiss accounts, which corresponds to approximately 15% of the total Swiss Twitter accounts. This number is achieved with only 240 of the 785 influencers. The system is still running and we hope to increase this number in the near future.

4 Discussion

In this article, the results are given mainly for the part dealing with localization. But the platform has been collecting data continuously for more than 15 months now and further analysis will be carried out in the future. In the meantime, we will improve classifier performance to detect all relevant tweets.

At the moment, the collection of followers of influencers is still in progress. Indeed, the limitations of the Twitter API make the process a little longer. We aim to create a dataset containing as many Swiss Twitter accounts as possible.

Acknowledgments. We would like to thank the FSVO for the funding of this platform and more particularly Françoise Fridez, Thomas Lüthi and Vincent Dudler, as well as the people who have participated in its design over the years: Laurent Zufferey, Laurent Chassot, Lucas Alborghetti, and Jérôme Vonlanthen.

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Emotional Work and Organizational Culture in Colombian Health Institutions. A Multidimensional Construction

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Abstract. Emotional work is an activity that influences the organizational culture of the health sector. The physical and mental activities of workers include emotional functions due to the type of service they provide, because it is part of the corporate image; constituting an excessive emphasis on the development of work [1]. For this reason, it is necessary to evaluate the psychosociological conditions and the consequences of emotional work in health services institutions in the city of Bogotá - Colombia. Methods, mixed study with descriptive scope of situations that affect the health of these workers. Population of 291 workers of 20 health units in Bogotá. Use of instrument battery for the evaluation of psychosocial risk factors. Levels of reliability in the questionnaires; intra-work of 0.957 and stress 0.83. Main psychosocial risk found, precariousness and precarious work based on the forms of recruitment and compensation in 72% of workers.

Keywords: Emotional work · Emotional burden · Precarious work · Job insecurity · Health

1 Introduction

The positions held in the health sector have an important influence on the appearance of conditions of emotional overload, in addition, the policies and practices determined by an organizational culture, and the development of emotional functions within their daily work, constitute the strategic determinants for the analysis and understanding of a worker's health and well-being.

Emotional work, in addition to carrying out activities with physical and mental requirements, becomes part of the worker's functions. It is thus elements of individual behavior, associated with the kind of service offered in face-to-face or voice-to-voice interaction, where the worker must influence the emotions, attitudes and behaviors of other people such as users, patients or clients, being each different interaction and with specific emotional requirements appropriate to these [1].

Expressions, smiles, gestures or words with friendly tones, are the emotional expressions that must express, being these, the materialization of the functions of emotional work, in order to influence and facilitate the sale or reception of the service offered by the worker.

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The quality standards and the corporate image of the institution demand behaviours on the part of the worker that compromises their emotional development.

In consideration of the above, the conceptual disruptor has a high influence in the workplace. This has an effect on a rule or a communicative process, altering the semantic. Consequently, there is a decrease in the socialization of work teams, affecting customers and consumers, as it is multidimensional [2].

The emotional functions of this work are basic for service companies, being each day more demanding.

Situations as greater demands in the market due to the competition determined by the market in which it operates. In addition, it has a high influence on the requirements determined by the economy of the service, focusing its action on providing high levels of quality for customer service. The image of employees is then the primary element of verification by management [3].

The research problem was determined in that the workers of the "institutions providing health services", included in this study, lack adequate identification of conditions and socio-labor consequences, with respect to emotional work.

Determining as main causes, a lack of internal identification of practices directly related to the activation of psychosocial risk factors, as well as a non-existent assessment of the exposure of workers and risk levels, as well as a precarious classification of the related processes to these, from the organizational management.

These facts open a panorama of reflection on the conditions in which the institutions provide the service, and the situation in which the workers face the work, subject to quality standards requirements according to each health entity.

For this reason, the objectives of this research consisted of:

To evaluate the socio-labor conditions and consequences of emotional work, in the institutions providing health services in the city of Bogotá - Colombia, identifying the practices that trigger the psychosocial risk factors, with respect to emotional work; differentiating the risk levels to which the workers are exposed, and determining the organizational management processes that are affected by them.

Another consideration of great importance is the relationship that the worker has with his coworkers, in the daily development of his activity. This element influences their ability to handle emotions because, in the employment relationship, dynamics affects in many cases significantly. The existence of stressful work relationships, caused by personality types or organizational dynamics and work environment are the causes of it.

Workers face, in their social relationships at work, psychological pressures that in many cases can be situations of "mobbing" or workplace harassment, making the situation faced by the worker even more risky. The World Health Organization (WHO) calls on nations to regulate these events, defining as main, the enactment of laws that are enforceable as fundamental in social and business contexts with dynamics of social relationship and respect.

Although many countries have this legislation, companies ignore, without taking the necessary control measures [4]. For this reason, the number of workers affected by adverse situations caused by emotional work increases year after year.

Consequently, emotions are considered a complex and multidimensional process that integrates physiological, motor and cognitive responses; with responses to primary survival reactions.

Emotions arise from situations that have the ability to stimulate and generate involuntary responses in the body of the person, having an interpretation according to their belief system.

Thus, emotional work triggers emotional dissonance in the worker, since he must align his feelings with organizational demands, generating a conflict in the role, and generating effects with a high probability of the development of Bornout (syndrome of being burned in the work), decreasing the perception of general health [5].

The above because there is a perception of work stress that increases, generating a mismatch in the resources of personal control and the demands of work [6].

2 Method

Mixed study with descriptive scope of situations that affect the health of said workers in the development of functions from emotional work.

A population made up of health personnel with professional positions (doctors, dentists, specialists, psychologists, nurses, administrative and service chiefs, among others), and operational personnel (auxiliary: health, administrative, customer service, maintenance, among others) 291 workers from 20 health units in Bogotá DC, Colombia.

Sample, non-probabilistic of voluntary participants, use of the Instrument Battery for the Evaluation of Psychosocial Risk Factors, instruments of individual conditions, with intra-labor reliability levels 0.957; non-work 0,944 and stress 0,83.

For the application of the instruments, the participants signed the informed consent following the ethical rigor for the study in humans.

2.1 Applied Instruments

1. Informed consent.
2. General data sheet: collects information on the individual characteristics of the worker and that are part of his sociodemographic profile.
3. Intra-labor questionnaire for bosses (form A), intended to investigate situations associated with the exercise of command, the execution of orders and the supervision of work.
4. Intra-labor questionnaire for operational personnel (form B), which establishes the situations faced by workers in the exercise of reception and execution of orders in their work.
5. Stress questionnaire, which establishes situations related to behavioral, psychoemotional, physiological, and social relationship symptoms.
6. Semi-structured interview questionnaire, to confirm the situations detected.

For the collection of information, management authorized and participated in the study.

2.2 Inclusion Criteria for Research

a. Participate in the call for the study (information campaign).
b. Sign of informed consent.
c. Have an employment contract with any of the health entities chosen in the sample.
d. Driving public or having permanent interaction with human beings.

2.3 Exclusion Criteria for Research

a. Workers hired in the same month of research development.
b. Background of mental diagnosis and treatment.
c. No signed informed consent.

3 Results

As results, it was determined that the social-work conditions, regarding emotional work, develops activities, person-person and voice to voice, for the attention of users in the entities providing health services, in about 96% of the tasks that are ahead, activities such as:

Attention to very worried or sad clients or users constitute 62% of the reports made in this study. In addition, a report of 51% of attention to clients or users very angry, that express attitudes or words, understood by the worker, as of abuse.

A "Very High" risk level of 59% with respect to intra-work conditions.

The dimensions of emotional demands and mental load, constituted for this condition, a level of risk "Very High" and "High" in 92% of this population.

In addition, 76% of the workers, in the customer service departments with the sub process of appointments or external consultation procedures, and the emergency units with all their processes, are the most vulnerable dependencies with risk levels of "Very High".

The units report absenteeism of 32% for headaches, influenza and gastric alterations.

Evidenced that (3.5%) 10 workers, register an anxious-depressive diagnosis with work origin.

Since 2014, there has been an increase of approximately 30% per year for the period 2014 to 2017, however by the year 2018, a 41% increase in the number of users of the institutions providing health services is established, in consequence increase of complaints in the attention and provision of the same.

72% of records per complaint in the forms of hiring and compensation for precariousness and job insecurity.

Report of "absence of own feelings" in 100%.

Evidence of great intellectual or sensory effort in 80% of workers.

4 Discussion

The "Superintendence of Health Services of Colombia" since 2014, reports a growing annual increase in complaints for the period 2014 to 2018, with a record of 1,824,599 claims. These, related to difficulties in the delivery of medicines, delay in the authorizations of laboratory tests, the null application of attention protocols and inconsistency in the news report [7].

However, review the reasons for the complaint, because they are mainly associated with the application of the care protocols at the discretion of the administration, which triggers non-compliance with them and activates non-conformities, attitudes and aggressive behaviour towards staff, which provides the service for violations.

This dynamism becomes toxic elements of the individual worker's experience and relationship with individuals of conflicting personalities in the case of clients and users. Unchaining critical situations for workers of these entities [2].

These facts offer a panorama of reflection on the conditions in which the institutions provide their services, as well as evidence of working conditions in which the workers perform the work. Being these activities; customer service requirements determined from the quality standards, large number of users, work teams without increase in the number of workers on payroll, precariousness and precarious work from the forms of hiring with low wages.

5 Conclusions

The emotional reaction of the worker caused by efforts, derived from emotional overload. These behaviors of nonconforming users, compared to the way in which the institutions providing health services, perform their daily work, which activate emotions and negative behavior that overloads more work places.

It should be noted that alterations in mental and physical health, bring increased absenteeism, accident, illness, desertion or job abandonment, in addition to a minimum forecast in the development of activities that are part of the processes involved, with respect to organizational management, increasing operating costs, reprocessing and dissatisfaction for internal and external customers [8].

It is necessary to have a broader knowledge of this population, because despite the multiplicity of research carried out, the emotional work approach, as a study phenomenon, is variable, because it is part of the dynamics of time and space. Because it depends on the social, political, economic and cultural aspects of the community, to which the client and/or consumer of health services belong.

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Healthcare Devices for Children: Strategies to Improve User Experience

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Abstract. Over the time, the concept of caring has undergone many transformations leading to a broader vision of its meaning. In this sense, taking care of oneself and others also implies taking care of the future. There are many aspects connected to the care design from social design to the more specific product design, such as to the design of daily use objects that have the aim of monitoring, improving, facilitating health-related practices and of psycho-physical well-being. The research refers to children as reference public and main users of care devices, because educating them to a good practice from an early age is surely an important aspect to take care of the future.

Keywords: Healthcare · Communication · Children · Well-being · Pediatric Hospital

1 Introduction: Context of Reference

1.1 Healthcare Devices for Children

The nature of children is to be curious; they usually spend a large part of their time playing, having fun, learning and discovering new things. If children feel themselves well, they move continuously all day becoming increasingly tired till they fall asleep. When they are ache or feel not well, they become irritable, they cry easily, and their mood is instable: it is very difficult to comfort them. During illnesses, the use of medical devices both at home and at hospital could become necessary. While at hospital the patient is generally passive in the use of medical devices, at home they have to use them in autonomous and active way. If the patient is a child, the use of device is generally assisted by parents. Their employment could be for monitoring body parameters, for administering a therapy or both, besides, the application for temporary or for life depends on the type of disease. These results come from the Future Health Index 2019. The research was concentrated on the role of digital health technology in improving both the patient care experience and the healthcare professionals. When we refer to children, as main users, it is very difficult to find healthcare devices "children centered design" and therefore the related practices become even more difficult to be carried out.

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1.2 The User Experience at Pediatric Hospital

During the experience of hospitalization, the child is never left alone. At his side he always has his parents, or the caregiver, in addition to doctors and nurses. However, he finds himself embarking on a very stressful experience, completely different from his daily routine. The child during hospitalization is completely passive, all medical practices are reserved to the medical staff. Inside the hospital the child has to deal, indirectly, with very technical medical equipment, often outdated, and most of the time not designed thinking of small patients, but only to the technicians. It is important, however, that this equipment reassure the child during the medical practice to which he is subjected, so as to make it as less traumatic as possible [1]. The types of hospital experience to which the child may be subjected could be divided into these four categories:

- *Long duration but temporary*. In case the child needs a long recovery in hospital but still limited in a precise period of time. This type of recovery can last weeks or months depending on the case.
- *Lifesaving/chronic*. In this case the hospital environment becomes a constant element in the child's routine.
- *Routine*. The child goes to hospital for routine scheduled checks (growth control, vaccines, sampling). This typology takes place within a few hours or a maximum of one day.
- *Extraordinary*. The child goes to hospital due to unplanned extraordinary events (first aid, hospitalization). This type of recovery can last from one day to one week.

1.3 The State of Art

As mentioned above, it is important that healthcare devices are designed taking into account children, as end users of the product, while being purely passive. However, it would be necessary to focus on finding design solutions aimed at making the child autonomous in performing healthcare activities, where possible, in such a way as to make him feel independent and master of the device. Currently there are few examples of healthcare devices "children-oriented". If on one hand, research increasingly employs new technologies and smart materials in order to make such devices as discreet and performing as possible, the great importance that both the emotional and the entertaining factor have in such devices for small users is still not duly recognized. It should be recognized that more and more attention is being paid to the environment [2], particularly in hospital areas where the most frightening treatments are made. Examples are the numerous TAC and MRI rooms in pediatric hospitals that turn into fantastic worlds where the child becomes a little explorer hero and medical devices his "technological shuttle". At home the child is a less passive user and can be involved actively, from the age of 3 years, in the activities of healthcare routine. In this regard over the years more and more healthcare devices, connected to smartphone applications, have been designed, through which entertain and at the same time teaching the child about that specific practice. Thanks to the ludic element given by the application, the child has fun while carrying out the routine and he is tempted to do it again. This solution has been experimentally applied also in healthcare devices for the nebulizer treatment.

In their study, Høiseth, Giannakos, Alsos and Asheim propose a concept for a healthcare game to be used before, during and after the nebulizer treatment [3]. Less fun and more informative applications have been developed in order to make the child, more conscious and autonomous about their illness. As instance this is the case of *RheumaBuddy*, an application for easy monitoring rheumatic disease.

2 The Aim of the Research

The research aims to propose a new approach in the design of healthcare devices for kids according to their needs and emotion, referring to their collective imaginary and using infantile language, in order to involve them in care activities, necessary for their health. In particular this work tries to define the factors necessary to design families of healthcare products to be used easily, independently and with pleasure by small users during daily life, at home and in pediatric hospital. In order to improve the well-being of children using medical devices, without discomfort in relation to other people and avoiding of feeling ashamed, it is necessary to render those devices more friendly and attractive. The purpose of the research is to guide designers and productors to design healthcare devices for kids able to appear familiar and ludic to interact and entertain children, using languages from their imaginary. Furthermore, the final objective is to offer a series of stimuli and possible points of departure for the birth of a new type of care products able to determine psycho-physical comfort, designed for children, as main users starting from their emotions. The achievement of these goals will also benefit parents who manage to keep calm, helping the child even more and making a better outcome of the monitoring/therapy. Even medical professional and pediatricians will benefit both in their relationship with children and in managing to use more easily and correctly the devices.

3 Methods of Research

3.1 "Children Centered-Design": Transdisciplinary Approach

The Design approach starts from the principles of the Human Factor Design, considering children, over three years old, as main users. The research refers to a transdisciplinary approach involving many disciplines as engineering for technical solutions, pedagogy, psychology pediatrics, necessary to understand children behavior. The contributions of each discipline represent the basic knowledge necessary to reach final design results. As described above, the healthcare devices have two main functions: the monitoring of body parameters – as thermometer - and the administering of a therapy – as aerosol -, sometimes they also have both together as glucometer. Besides, the typology of device depends on disease and on user scenario. Children have different skills depending of their age [4], various emotions according to the aspects of the environment, [5] the awareness of what they will have to do, [6] the knowledge of the related modalities and finally their state of health.

As a matter of fact, from the birth to adult age, young people have a continuous development of physical and psychical abilities, necessary to know for designing according to children centered design approach. Children usually live daily experience with objects. Their favorite ones are toys but, very often, they are also attracted by adult's ones as, for instance, ladles and lids of pot, washing machines, sunglasses, ornaments, and all the objects able to attract and interact with them through colors, curved shapes, reflecting surfaces, noises and movements. In conclusion the objects become attractive if they involve children in playing activities. As underlined by Piaget [7], during playing, children show their needs, their own emotions. Besides, also products are able to suggest behaviors directly related to emotional aspects [8] representing the engines of psycho-physical development of children. Certainly, the designers will have to take into account this information when designing healthcare devices for kids. Moreover, the research undertakes a co-design approach that has been experimented as follow:

1. direct observation of children, as patient, at hospital;
2. co-working activity at school to understand children mood and desires if using healthcare devices;
3. meeting with psychologist and pedagogists to investigate what children needs against fear using this kind of devices.

3.2 Direct Observation

Direct observation involving children at pediatric department of AOU in Sassari (Italy), showed how children were interacting with healthcare devices, underlining a set of practices connected to it, with and without parents' help. The method's application points out, that very often children are afraid of the equipment used by medical professionals. The observation also showed that children are less scared if the pediatrician use to entertain or distract them, or if they were more familiar with the treatment.

In fact, in the case of children hospitalized because of chronic diseases, they were quite indifferent to the department routines treatments.

3.3 Workshop with Children

The coworking involved children of selected primary schools in Pisa (Italy). During the activity children (6–11 years old) were asked to tell their experience at hospital as patient. A lot of them told that they were scared during the visits, others were confused by the reason of their presence in the hospital. Besides, children were asked if they were afraid of using medical devices at home. The interviews underlined that children are afraid of using medical devices and they need to be reassured using them both at home and at hospital. After the interviews, a workshop has been organized for two weeks involving students in drawing their own new healthcare device. The purpose of this workshop was to provide feedback from children on designing their favorite device. Children drawings underlined the importance of playful and interactive aspects of devices.

3.4 Meeting with Psychologists

This third phase involved a group of developmental psychologists in order to evaluate the results emerged from the two previous phases and to investigate the explicit and implicit needs of children during use of the healthcare devices. Research has highlighted the importance of the ludic element as a form of active distraction [9] for the child while using of the devices, in order to make the activity more appealing.

4 Results of the Research

4.1 Design Consideration

The present work states that medical devices for children have to be design using signs/elements from their imaginary to facilitate the use in autonomy, to stimulate interaction, entertainment and playing for emotional well-being of children. According to these factors it is necessary to insert ludic elements within care devices, a fundamental factor when designing for children as main user in order to engage, intrigue and make them establish a playful interaction with the product and its functions. Besides child experience, during the use of medical devices, should be such as to gratify the child himself, so as to make him desire repetition, that is desirable in this type of products. As a result, the research proposes a series of consideration, which are easily applicable to design different kind of pediatric devices, to be used both at home and at hospital. The work underlines the need to set specific solutions according to:

1. age of children
2. time for single device use and frequency of use
3. user scenario

All of the above variable elements determine the need of different design solutions. In any case ludic and reassuring aspects are the main peculiarities in common that all of them need to have. It follows that during the interaction/experience with healthcare devices, children need to feel them calm and at ease. It generally could happen if the device has a familiar morphological shape to look like something known in their imaginary. The use of curved shapes, soft touch surfaces, bright colors help to reach these goals. Moreover, the shapes have to be related to their functions, in this way children, over 6/7 years old, could have awareness of the actions they are subjected to, using a healthcare device alone or with the help of an adult and as consequent they are not afraid of it. These strategies, improving child experience, are able to make care devices and their use more “familiar” both at home and in a place never seen before, as the hospital, making the child feels at ease, avoiding or reducing the stress that these practices could bring.

5 Conclusion: Workshop with Design Students

In this paper we have identified a set of design considerations to define the healthcare device experience for children, specially according to their emotions. These principles are, at the same time, a conclusion and a starting point. As starting point the research proposed an experimental workshop activity arranged with a group of 50 students attending the third year of the industrial design degree course at the University of Florence, (Italy). During the workshop each student had to design innovative concept of healthcare devices for children 3–11 years old according to the factors above proposed. The projects are in progress and we hope to develop and evaluate some of these ones together with the equip of the Pediatric Hospital in Sassari.

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Author Francesca Morelli has written the following Sects. 3.3 and 3.4.

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HypnOS: A Sleep Monitoring and Recommendation System to Improve Sleep Hygiene in Intelligent Homes

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Abstract. Sleep is important for many vital functions. Unfortunately, many people suffer from sleep-related problems, which have negative consequences on sleep quality and therefore on quality of life. Considering the important health benefits of a good night's sleep, it is crucial to investigate technological solutions that promote and improve sleep hygiene. To that end, the HypnOS framework for "Intelligent Homes" is introduced, aiming to improve the sleep quality of home residents by monitoring their sleep and providing personalized recommendations to overcome sleep-related issues. It describes the design process that was followed, presents its functionality, reports the findings of an expert-based evaluation of the HypnOS mobile app and discusses future plans.

Keywords: Sleep monitoring · Sleep hygiene · Ambient Intelligence

1 Introduction

Sleep is important for physical and mental health [1, 2], as well as for the overall well-being. Nevertheless, significant public health problems with high prevalence in the community, such as excessive daytime sleepiness [3], sleep deprivation and sleep fragmentation [4] are caused by abnormal sleep quantity or quality. These have been postulated as contributing factors to the development of many conditions such as insomnias, obesity and cardiovascular diseases [2, 5]. A common approach for overcoming such issues is sleep hygiene, which refers to a variety of different practices and habits, necessary to have good nighttime sleep quality and full daytime alertness [6]. Considering that today's technology can help people in their everyday lives [7], it is crucial to investigate solutions that monitor the sleep patterns of individuals, identify sleep-related issues, and provide effective guidance to improve their sleep hygiene.

During the past few years, continuous technological improvements have led to the introduction of an abundance of sophisticated sleep trackers (e.g. sleep tracking pads), while individuals can also use their own smartphones and wearables to track their sleep habits without acquiring any additional equipment [8] (e.g. recording equipment used

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in clinical sleep studies). Although many technological improvements opened the way towards sleep monitoring, a holistic approach that takes advantage of the already prominent Ambient Intelligence (AmI) [9] technologies rather than merely relying on isolated devices, is still missing. This work introduces the HypnOS framework, which apart from acting as a sleep monitoring mechanism, interoperates with the "Intelligent Home" of ICS-FORTH in order to infer knowledge regarding the sleep quality of the inhabitants and provide effective guidance to improve it.

2 Related Work

Traditionally, the "gold standard" of detecting sleep-related issues is polysomnography (PSG) [10, 11], an overnight sleep monitoring study performed in a hospital or sleep clinic that combines multi-channel recordings like electroencephalography (EEG), electromyography (EMG) and electrocardiography (ECG). However, due to the requirement of special equipment, it is usually limited to clinical settings. Nowadays, several research studies have investigated sleep technology and approaches to monitor sleep behavior at home (i.e. collect data about individuals' sleep patterns). Most of them are mobile applications that utilize the built-in phone sensors to monitor sleep and predict its quality. For example, the BES model [6] uses a sensor-based inference algorithm to predict sleep duration by exploiting various smartphone usage patterns (e.g. screen time) and environmental observations (e.g. prolonged silence and darkness). iSleep [12] and Toss 'N' Turn [13] capture data from phone sensors (e.g. accelerometer) to detect sleep measures (e.g. duration, disturbances) and infer sleep quality by using a daily sleep diary based on the Pittsburgh Sleep Quality Index [14], a self-rated questionnaire assessing sleep quality and disturbances. Apart from sleep labs, many of these approaches were commercialized through mobile applications, which can: record bio-signals, track sleep patterns, detect snoring, provide detailed sleep reports and wake up users during their lightest sleep phase [15, 16].

Regarding systems that promote sleep hygiene, SleepTight [17] is a self-monitoring application which provides feedback to help people change their behavior by capturing sleep measures from a sleep diary and contributing factors (e.g. meals, exercise, caffeine) from an activity section. Similarly, ShutEye [18] uses the phone's wallpaper to inform users about how their daily activities (e.g. vigorous exercise) may disrupt their sleep. Furthermore, SleepScore [19] and Pillow [20] offer personalized recommendations to make users aware of the importance of healthy sleep habits. Moreover, there are plenty of mobile applications, which aim to relax users in order to help them fall asleep effortlessly, by employing appropriate techniques such as meditation [21], storytelling [22] and soothing sounds such as forest soundscapes [23].

3 Design Process

An iterative, User-Centered Design [24] methodology was followed, with special attention given to the pre-design stages, as described in the Design Thinking process [25]. The Empathise step of the process requires gaining an empathic understanding of

the problem under investigation. To this end, the design team consulted with three experts from a sleep research laboratory (Sleep Disorders Center, Department of Respiratory Medicine, Medical School, University of Crete) in order to gain their valuable feedback and insights. The most important outcome was the establishment of the actual scope of the system. In more detail, it was suggested that HypnOS should not provide medical-level services, since the required equipment for retrieving medically acceptable data would make the system far too obtrusive for a home environment. Additionally, it was made clear that patients in sleep labs are often overwhelmed by the level of surveillance, which includes electrodes attached to various places on the body and head, cameras recording the patient all night, which results in discomfort and is generally an unpleasant experience. Therefore, in the Define step of the process, it was decided - with the agreement of the sleep experts - that the scope of the system would be to monitor, as unobtrusively as possible, the basic sleep patterns of individuals. It was also suggested that in combination with the monitoring of their daily habits - through other ambient facilities of the "Intelligent Home" - the system could offer valid insights in form of advice to improve sleep hygiene. Next, for the Ideation step of the process, several brainstorming sessions took place - with the presence of sleep hygiene experts - during which dozens of ideas were produced and then filtered appropriately (e.g. unsuitable solutions for domestic environments such as Polysomnography). The Prototyping phase started by creating a realistic 3D representation of the room (Fig. 1) and continued with the design of low and high-fidelity prototypes of the HypnOS app. Lastly, before proceeding with user testing, the overall setup and the application prototypes were iteratively evaluated by experts so as to uncover issues in terms of interaction and ergonomics.

4 HypnOS Approach

The vision of HypnOS is to create an unobtrusive sleep monitoring system for "Intelligent Homes", able to detect sleep abnormalities and provide personalized sleep hygiene guidelines in order to improve sleep quality. It is deployed in the technologically enhanced bedroom of the "Intelligent Home" simulation space located at the AmI Facility within the FORTH-ICS campus (http://ami.ics.forth.gr/). The facilities of the "Intelligent Bedroom" work in conjunction with **AmIHomeOS** [26] - the distributed computational framework of the "Intelligent Home" - in order to transform the room into an all-inclusive environment, able to: (i) accommodate various use cases (e.g. sleep monitoring, getting dressed), and (ii) assist various user groups (e.g. a family of four, an elderly couple, a disabled single adult) in an intelligent and personalized manner. In more detail, its hardware infrastructure consists of: (i) an extensive grid of sensors and actuators that monitor and control various aspects (e.g. environmental conditions, motion sensors, under the mattress pads), (ii) smart commercial equipment (e.g. lights, speakers, locks, aroma diffuser), (iii) devices and wearables (e.g. smart watches, smart wristbands of various sorts, EEG devices, smart TVs, tablets, smartphones, smart speakers), and (iv) technologically augmented custom-made furniture (e.g. clothes hanger, nightstands, wardrobe [27]). Especially for sleep monitoring purposes, the SleepCompanion artefact was developed; it is a commercial bed integrating sensors like

Withings Sleep Tracking Mat (https://www.withingscom/mx/en/sleep) and Emfit QS Sleep Tracker (https://www.emfit.com/) and constitutes the key artifact of the bedroom.

HypnOS exploits the above hardware infrastructure in order to monitor the physical activity (e.g. movement, bed time), the bio-signals (e.g. respiration rate, heart rate, snoring) and various sleep-related parameters (e.g. time to fall asleep, time asleep, time awake, sleep cycles) of the residents while in bed. The sophisticated mechanisms of HypnOS fuse data from the various devices and sensors and combine them with contextual information revealing residents' daily habits (e.g. caffeine consumption, stress levels, fitness activities). Such data are available through the ambient services of the "Intelligent Home" (e.g. Nutrition service) and allows the system to gain insights about the causes of the residents' sleep-related issues and act accordingly.

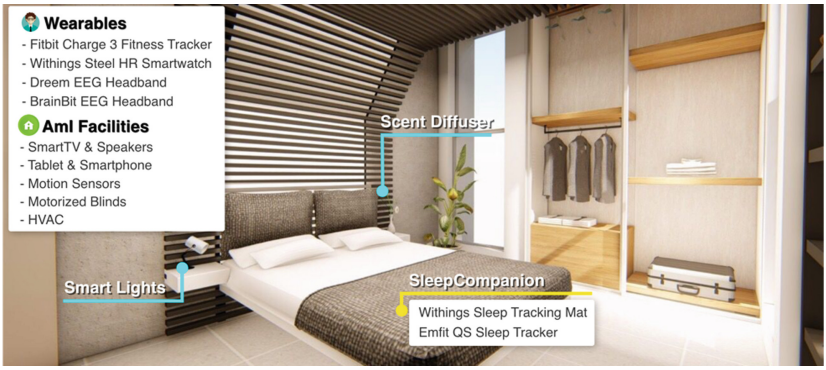

Fig. 1. Realistic 3D representation of the room

From a user perspective, the HypnOS mobile app facilitates control over the system and offer a detailed sleep report including – amongst others – details regarding sleep patterns, movements during sleep, hours of sleep, etc. Most importantly, the application offers a recommendation system in the form of personalized sleep insights in order to motivate users to change their daily habits that affect sleep (e.g. "Drinking coffee two hours before bed time might negatively affect your sleep"). Additionally, a smart alarm clock detects the optimal time, within a 15-min timeframe, to wake up users gently (i.e. when they are in the lightest possible sleep stage) and adjusts a variety of environmental factors (e.g. blinds, temperature, music) to achieve that.

Finally, HypnOS interoperates with the CaLmi system [28], which is a system that enables the ubiquitous presentation of relaxation programs in Intelligent Environments to manage the stress level of individuals, aiming to help residents relax and fall asleep effortlessly. In more detail, HypnOS can, on demand initiate and personalize any of the available relaxation programs (e.g. music therapy, visual exposure to natural environments) offered by CaLmi, in order enhance the bedroom's environment (e.g. lights, sound) and create experiences that can potentially improve sleep hygiene.

5 Heuristic Evaluation of Mobile Application

In order to proceed with user testing without any major usability errors, a heuristic evaluation experiment [29] was conducted. The process involved the examination of the HypnOS app UI by five expert evaluators, who judged its compliance with recognized usability principles. The identified usability issues, were merged into a single list and each evaluator was asked to rate them in terms of severity. These ratings, ranging from zero ("not a usability problem") to four ("usability catastrophe"), were afterwards used to prioritize the issues according to their severity. Our findings revealed 46 usability issues, out of which 4 were ranked as aesthetic cosmetic problems, 35 as minor usability problems, and the remaining 7 were ranked as major issues. Most of them concerned general interface inconsistencies (e.g. variations in button sizes) and aesthetics (e.g. colors). Additionally, it was identified that some components did not communicate their functionality to the user (e.g., the current day on sleep diary calendar did not appear as clickable), while others missed easy access to functionality (e.g. play button for the available relaxation programs). Finally, the most important finding was that users expected to find the Sleep Insights (offered by HypnOS) into a dedicated page. According to the development team - that ranked the issues on a scale ranging from zero ("extremely easy to fix") to three ("difficult to fix") - most of them will require minimum to none effort to fix.

6 Conclusions

This paper described the HypnOS framework and app that offer a holistic approach towards improving sleep quality. Analyzing information collected in an unobtrusive manner (e.g. sleep measurements, bio-signals and contextual information), HypnOS provides appropriate recommendations - depending on the identified sleep-related problems - for improving sleep hygiene. The ultimate goal is that the "Intelligent Home" of FORTH-ICS will be able to accommodate end-users, who can live in the house for short periods to intensively evaluate in-situ the HypnOS system. To that end, a longitudinal user-based study will be organized to take place, not only to assess the performance of this approach but also to fully examine the user experience of living in a home with such ambient facilities.

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Mathematical Modelling and Computer Analysis of Diabetes to Develop Novel Index for Diagnosis and Risk Prediction of Pathogenesis

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Abstract. A simple model for diabetes has been considered and represented mathematically in terms of reaction rate equations. The diabetic states determined by the relative intensities of reaction parameters included in the model have been investigated by numerical calculations. This mathematical model could realize the diabetic and non-diabetic states, namely, the change in states according to dietary intake, insulin secretion, and physical activity. Based on these analyses, it has been proposed that, if the parameter set in the model was evaluated for individuals and saved as a clinical database, it could be used for diagnosis, treatment, and risk prediction for diabetes pathogenesis.

Keywords: Mathematical modelling · Diabetes · Disease risk

1 Introduction

The morbidity of diabetes has been expanding worldwide during these decades, evoking the necessity of measures to this disease. The index of the modern standard diagnosis for diabetes are the blood glucose level, glycated hemoglobin (HbA1c), glycoalbumin (GA), C-peptide index, body mass index (BMI), abdominal circumference and so on. The genomic medicine is in progress for identifying overall diabetes-relating genes as an end in view, and thereby implementing personalized medicine and risk prediction of diabetes pathogenesis. In this context, the present study has proposed another type of index by mathematical modelling and computer analysis of a simple metabolic system that regulates carbohydrate metabolism. It is distinctive of this novel type of index that the index does not represent extensive variables indicating amount of substance such as blood glucose but intensive variables indicating metabolic ability of a person.

2 Simple Metabolic Model for Diabetes

Figure 1 illustrates a metabolic model for diabetes. The insulin is secreted into blood, following increase in blood glucose, and promotes taking glucose into adipocytes. However, excessive dietary intake gives rise to hypertrophy of adipocytes, and the

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enlarged adipocytes induce the secretion of inflammatory cytokines [1, 2]. These cytokines hinder the function of insulin, leading to inability of taking glucose into adipocytes (insulin resistance) [2] and decrease in one's weight. In addition, long-time duration of high blood-glucose state is responsible for disorder of insulin secretion (glucotoxicity) [3]. Diabetes develops via such processes.

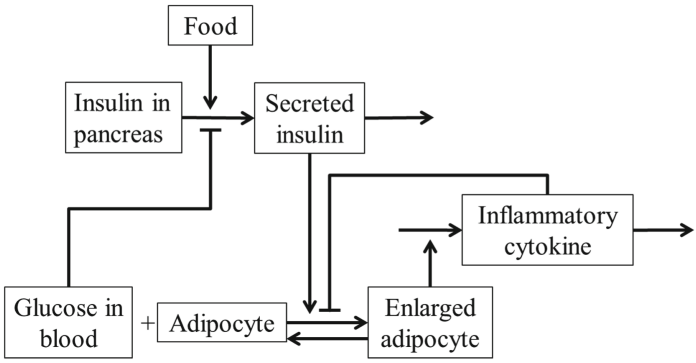

Fig. 1. Model of insulin resistance, glucose toxicity, and diabetes. The laterally directed arrows describe reactions or changes, and the vertical arrows denote activation of reactions. The T-shape symbols denote inhibition.

3 Mathematical Modelling

The processes shown in Fig. 1 can be described as reactions and written as

$$\mathrm{G} + \mathrm{f} + \mathrm{S} \rightleftharpoons \mathrm{X} \rightarrow \mathrm{F} + \mathrm{S} \tag{1}$$

$$\mathrm{S} + \mathrm{I} \rightleftharpoons \mathrm{Y} \tag{2}$$

$$\mathrm{i} + \mathrm{F} \rightleftharpoons \mathrm{Z} \rightarrow \mathrm{I} + \mathrm{F} \tag{3}$$

where G, S, f, F, i, and I denote the amount of blood glucose, insulin, the mass of normal and enlarged adipocytes, and the amount of unreleased and released inflammatory cytokines, respectively, and X, Y, and Z are transient products.

These reactions are written mathematically in terms of rate equations; namely, the time evolution of these variables are described by differential equations [4–6]. Here, the rate equations are approximated by functions of the Michaelis-Menten type which is known as a model for enzyme kinetics, and written as

$$\dot{G} = k_G - \frac{\sigma_T k_a G f}{(1 + k_a G f + k_b I)}, \tag{4}$$

$$\dot{F} = \frac{\sigma_T k_a G f}{(1 + k_a G f + k_b I)} - k_F F \tag{5}$$

$$\dot{I} = \frac{i_T k_c F}{(1 + k_c F)} - k_I I \tag{6}$$

where k_a, k_b, k_c, k_F, and k_I denote parameters obtained from reaction rates, and we assume that the amounts of secreted insulin, adipocytes, and unreleased inflammatory cytokines are constant, i.e., $S(t) = \sigma_T$, $f(t) + F(t) = f_T$, and $i(t) = i_T$.

Equations (4)–(6) provide the zero-growth isoclines (nullclines):

$$k_a G f = \frac{k_G}{\sigma_T - k_G}(k_b I + 1) \tag{7}$$

$$k_a G f = \frac{k_F k_I I (k_b I + 1)}{-k_I I(\sigma_T + k_F) + \sigma_T i_T} \tag{8}$$

The fixed point (I_0, G_0) obtained from the intersection of these nullclines is

$$(I_0, G_0) = \left(\frac{k_G i_T}{k_I (k_G + k_F)}, \frac{k_G (k_b I_0 + 1)}{(\sigma_T - k_G)(f_T - k_G / k_F)} \right) \tag{9}$$

This expression of the fixed point reveals that the relative intensities among k_G, k_F, and σ_T are important, determining the sign for the G_0 element of the fixed point, and the location in the variable space.

4 Diabetic States and Numerical Calculations

The expression of the fixed point, Eq. (9), provides non-diabetic and diabetic states, depending on the relative intensities of σ_T, k_G, f_T, and k_F. The qualitative features are classified into four cases.

Case I: $\sigma_T > k_G$ and $f_T > k_G/k_F$

When the dietary intake is normal and the insulin secretion is sufficient, the metabolic system stays in the. non-diabetic state. Figure 2 shows the G-I plane of the variable space. In Case I (Fig. 2(a)), the fixed point is located in the first quadrant (positive area) of the plane. It is found that the fixed point acts as an absorber for the trajectories (thin solid curves), (I(t), G(t)) where t denotes time. The trajectories approach the null cline, Eq. (7), and merge on it; then, they are eventually absorbed into the fixed point. This behavior on the G-I plane implies that the amounts of blood glucose and inflammatory cytokines are regulated to be finite values in the non-diabetic state.

Case II: $\sigma_T < k_G$ and $f_T > k_G/k_F$

When the dietary intake exceeds the supply of insulin, the diabetic state appears. The fixed point sinks under the G = 0 line so that the trajectories cannot approach the fixed point (Fig. 2(b)). Instead, they approach the nullcline Eq. (8) (thick solid line), and clime it from the right-hand side. This behavior represents that the blood glucose increases in the state of high-calory diet.

Case III: $\sigma_T > k_G$ and $f_T < k_G/k_F$

Despite normal dietary intake, if the decay rate of enlarged adipocytes k_F is small, the fixed point sinks under the G = 0 line. The trajectories assemble from the right and left sides, and climb upwards. It may be possible to consider that the small value of k_F indicates deficiency of physical activity.

Case IV: $\sigma_T < k_G$ and $f_T < k_G/k_F$

The worst case for a human occurs when the dietary intake exceeds the insulin secretion and the decay rate of enlarged adipocytes is small. In this case, the fixed point is located in the positive region of the G-I plane; however, it does not function as an absorber of the trajectories. The trajectories assemble and merge near the singular line (broken line) on which the denominator of the null cline Eq. (8) equals zero. Then, they climb along the singular line. This case also exhibits increase in blood glucose with time, i.e., pathogenesis of diabetes.

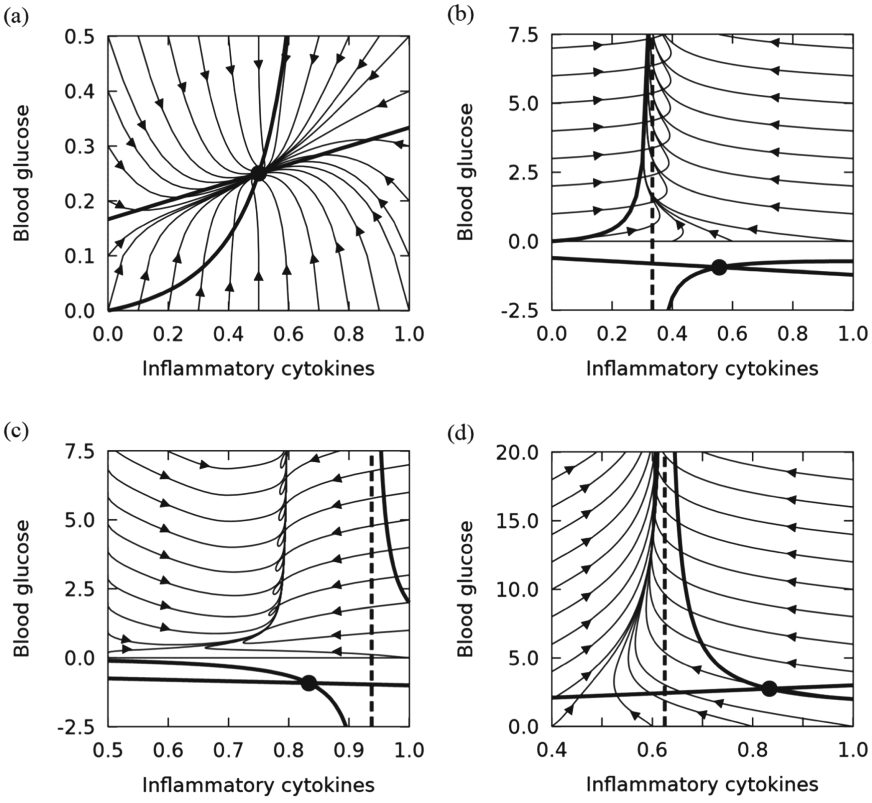

Fig. 2. Four types of diabetic states on the G-I plane of the variable space. The null clines and fixed points are shown by thick solid lines and solid circles, respectively. The broken lines are the singular lines on which the denominator of the null cline Eq. (8) equals zero. The trajectories calculated numerically are depicted by thin solid lines. The arrows on the trajectories indicate the direction of time evolution. The parameters are set to $k_A = k_B = k = k_I = 1.0$ and $f_T = 4.0$. (a) $\sigma_T > k_G$ and $f_T > k_G/k_F$: $(k_G, k_F, \sigma_T) = (1.0, 1.0, 3.0)$, (b) $\sigma_T < k_G$ and $f_T > k_G/k_F$: $(k_G, k_F, \sigma_T) = (0.5, 0.4\ 0.2)$, (c) $\sigma_T > k_G$ and $f_T < k_G/k_F$: $(k_G, k_F, \sigma_T) = (1.0, 0.2, 3.0)$, and (d) $\sigma_T < k_G$ and $f_T < k_G/k_F$: $(k_G, k_F, \sigma_T) = (3.0, 0.6, 1.0)$.

5 Index for Diabetes Diagnosis, Treatment, and Risk Assessment

The precise location of the fixed point must be determined by more quantitative evaluation of the parameters, (k_a, k_b, k_c, k_F, k_I), included in the rate equations. This parameter set may be used for diagnosis, treatment, and risk prediction for diabetes. Actual remedy targeting human would require to measure and evaluate these parameters in detail; they seem to be implemented by medical testing or biological experiments. For example, hypertrophy in adipocytes can be examined by periodic sampling of adipocytes, and thereby the variation rate for the hypertrophy can be evaluated. The variation rate for inflammatory cytokines can be also investigated in the same way. In addition, it is expected that, following such actual measurements, the mathematical model can be improved and updated, and vice versa.

The parameter set varies person to person, and therefore, statistical analyses of many private records for the parameter set would be very useful for diagnosis, treatment, and risk assessment. It is desirable that the results of the statistical analyses are saved as a clinical database so that not only hospitals but individuals can access it for medical purposes. Clearly, such a medical system could be applied to other diseases; an important point is the construction of mathematical models with good quality.

6 Concluding Remarks

The present study has considered a mathematical model for diabetes, and the diabetic states determined by the relative intensities of reaction parameters have been investigated by numerical calculations. It has been proposed that the parameter set could be used for risk prediction of diabetes as well as diagnosis and treatment.

This mathematical model is based on many simplifications, whereas it is better that rough estimates provide good suggestions than that too exact calculations reveal useless results. Interactions between mathematics and medicine would open up possibilities, providing novel types of therapy.

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Lean Healthcare Model Using Knowledge Management and Change Management Approaches to Reduce Delays for Care in the Health Sector

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Abstract. This study was developed at a private health care center with problems in its emergency department, which had a process efficiency of 39.6%. As such, implementing a lean healthcare model was proposed using knowledge management and change management as it pillars. As a result, employees were committed to change, which facilitated the transfer of knowledge when implementing the lean tools, reducing waiting time in the process by 67.01% at its highest level, while an efficiency of 63.87% was achieved.

Keywords: Lean healthcare · Knowledge management · Change management · Emergency department · Waiting time

1 Introduction

Currently, the Americas rank third as a continent with the highest percentage of GDP invested in the health sector. However, the situation in several Latin American countries has not changed even in recent years.

Peru is one of the countries with the smallest budgets allocated to the health sector when compared to other countries in the world, causing significant problems for the sector [1]. According to the National Health Authority (SUSALUD, for its Spanish acronym), in 2016, more than 6 million soles were imposed as fines, out of which 69% were related to the private sector. Likewise, SUSALUD states that delays in care is the most common problem at health centers (43.2%) [2].

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Delays in emergency medical care is not an issue that affects only Peru; several countries worldwide have deficiencies in their processes and the necessary use of tools and techniques to improve their current situations. According to Mandahawi, Crema, Tsai, and others in their studies carried out at medical institutions, waiting times is a global concern, as waiting for care to be administered can result in adverse outcomes for the patient [3–5].

This research study seeks to minimize the costs incurred because of inefficiencies in the emergency care process and to reduce patient waiting times, using lean tools and/or techniques to identify and eliminate waste and reduce waiting times for care.

2 State of the Art

2.1 Lean Healthcare in the Health Sector

The use of the lean methodology in health systems improves processes, eliminates unnecessary activities, reduces process variability, and improves communication in the establishment; thus reducing workflow errors by up to 84.38% by using a Kaizen system [6] and decreasing waiting times by up to 24% by using Lean Six Sigma [7]. Likewise, the length of patients' stays within the clinic was significantly reduced from 148 min to 72 min [8]. Despite using different proposals to solve health care problems, most authors agree that it is necessary to define the "voice of the customer," that is, to understand what generates value for the patient and to improve the process based on their vision. Furthermore, using the lean methodology provides continuous improvement for the area or case under analysis where the lean approach is implemented [6–8].

2.2 Lean Healthcare and Knowledge Management in the Health Sector

In the lean healthcare typology and knowledge management, achieving successful knowledge management in health care improves employee satisfaction and motivates them to be innovative in their work areas. However, there should be constant monitoring of the knowledge acquired and employees' motivation because poor management can cause deficits in employees' operational performance and their reluctance to continue acquiring knowledge [11, 12] [13].

2.3 Lean Healthcare and Change Management in the Health Sector

The use of change management enables workers to understand the need for change within their work area, which leads to greater willingness to improve their daily activities. Despite several authors presenting different proposals to achieve successful organizational change, each one is based on the Kurt-Lewin model that summarizes change in three phases: unfreezing, changing, and freezing [15, 16, 17, 18].

3 Contribution

3.1 Proposed Model

Figure 1 shows how the selected lean tools are developed in a sequential and synergistic manner, creating a cycle of continuous improvement. Transferring knowledge is part of each phase, given that an explanation must be given to each project participant on the methodology to follow.

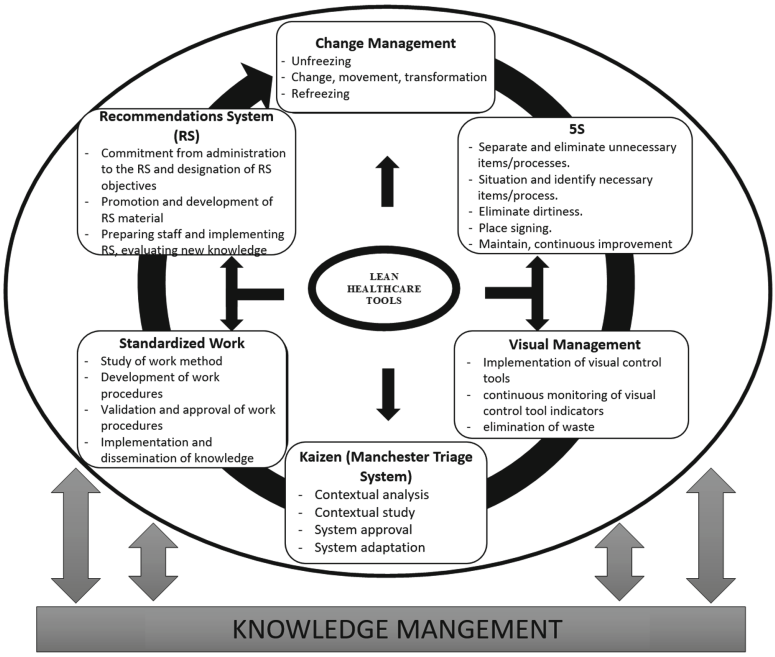

Fig. 1. Proposed model

Change Management. Change management facilitates the understanding on the need for change and motivates employees to learn better ways of carrying out their activities. Therefore, it must be implemented at the start of a project to ensure its success.

Knowledge Management. Implementing any knowledge management initiative requires basic knowledge on change management and on improving processes. Knowledge management is fundamental throughout the development of a proposal to efficiently generate and transform information into knowledge through human, structural, and relational capital.

5S. The use of the 5S tool optimizes the work environment, contributes to the work of employees, and develops their skills to identify problems. The work area was cleaned and organized for employees to work in a more orderly manner, with greater efficiency and in less time.

Visual Management. Visual management is implemented to provide support to 5S and verify compliance of the activities established in the prior step through a visual approach that improves communication in the work place.

Standardized Work. Process standardization is required to close the change management cycle and establish the work methodology for the corresponding employees in the area under analysis. Likewise, it enables a work study to be carried out in order to monitor the resulting improvements.

Recommendations System. Lastly, in order to achieve continuous improvement, Phase 5 was developed, which entails using a suggestion system that enables staff to identify new problems and improve the emergency process, attaining staff involvement and benefiting patients, workers, and the health care center.

3.2 Proposed Method

A flowchart of the proposal's implementation following a general framework for its application is presented below (see Fig. 2):

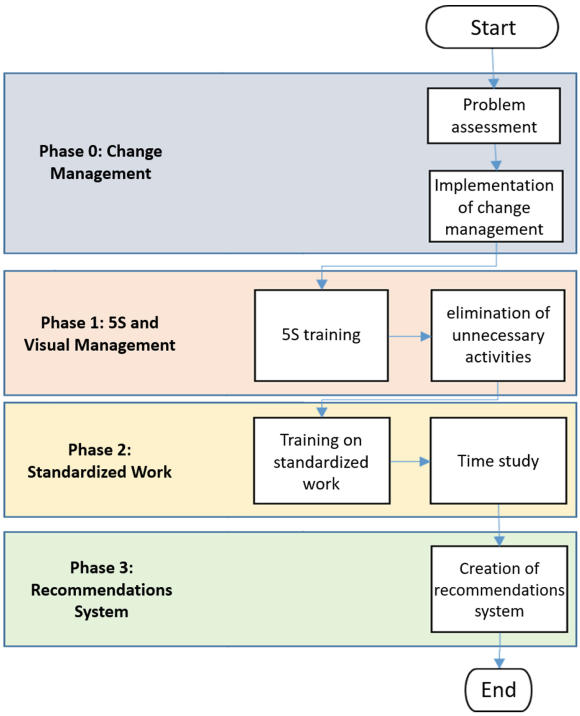

Fig. 2. Implementation flowchart

3.3 Indicators

5S Audit Score

$$5S\,Audit\,Score\,100 - \left(\sum_{i=1}^{5} Subtotal_i\right) \quad (1)$$

The score obtained marks the level of an area's current situation, with 60 being the minimum significant reference score and 100 being the maximum score obtained.

Waiting Time. The time obtained in minutes shows the current situation in which the patient is performing activities that do not add value. It must be taken into account that 20 min is the minimum waiting time and 60 min is the maximum for regular emergency consultations.

Process Efficiency. The percentage obtained shows what portion adds value to the process in comparison to the cycle time, taking into account that the minimum required is 55%.

4 Validation

4.1 Case Study

The case study took place at a private company in the health sector, whose mission is to maintain its high quality of service and become the best private clinic in terms of service quality. The emergency department primarily attends to three types of patients: regular emergency patients, patients who require immediate care, and pediatric patients.

4.2 Assessment

Prior to the assessment of the emergency department (ED), the process to study and improve was defined because it was discovered that the ED attends to regular patients on a more frequent basis, which indicates a greater focus on this class of patients.

In the research study carried out at the clinic, through analytical tool processes (value added analysis, value stream mapping, and a work study), the following indicators were calculated (Table 1):

Table 1. Initial indicators

Indicators	Before	Observation
5S audit score	57	<60 min
Waiting time (min)	47.9	<60 min
Process efficiency (%)	39.64	<55%

4.3 Implementation of the Proposed Method

Phase 0: Change Management. Validation of Phase 0 began with an assessment of the current situation to highlight process inefficiencies and their impacts on the ED under analysis. This was followed by a survey on resistance to change to obtain an initial score of the project. Once the survey was conducted, the change management methodology was applied so that employees understand the need for change and the benefits it entails. This led to several questions about the lean philosophy and doubts about the project to be implemented were aired. Once their doubts were cleared, the project began with a group of three doctors, two nurses, and one administrator to have an approach that covered the entire ED.

Phase 1: 5S and Visual Management. The first phase began with training on 5S that explained the philosophy, objectives, and targets to achieve in a manner in which the staff understood what was going to be implemented. The application of the 5S philosophy started with an audit that showed the current situation of the department and each workstation. The result achieved was a score of 57 due to weaknesses in orderliness, organization, and cleanliness. Consequently, a meeting was held with the group to understand the current situation and to start brainstorming proposals on how to improve each situation.

Phase 2: Standardized Work. Afterward, training was provided on standardized work that showed the objectives and their targets. Each procedure was recorded using the work study methodology to document the process cycle and each requirement by activity for future improvement and to maintain a standard work methodology. In this manner, workers understand their routine state, thus concluding the change management cycle.

Phase 3: Recommendations System. Lastly, staff was trained on the recommendations system and the importance of contributions from each employee to improve their workstation. Once the training was completed, a suggestions system was proposed in order to use the staff's ideas with the objective of improving the organization.

5 Conclusions

Despite a low initial score in the 5S audit, through the work team's collaborative effort, the required 60 points was surpassed and an improvement goal of 45% was proposed.

The staff's commitment during the transfer and application of knowledge in the research project was essential, which made it easier to achieve the established objectives.

Knowledge management and change management are two methodologies that must be simultaneously developed to ensure project success, given that participants are more willing to learn new ideas if they understand the positive aspects that change entails, both for them and the organization.

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Development of User-Drawn Doodles for Communication and Reporting of Dietary Intake in Health Management

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Abstract. The use of machine learning to support health-related activities is yet to be adequately explored. We present a concept of using user-drawn doodles for communication and reporting of food item and its portion size. This paper aims to devise innovative applications for existing ML-based services. A prototype mobile app is developed and demonstrated. We invite three senior dietitians to evaluate its potential. Analysis is proceeded in used of affinity diagramming. The expert evaluation concluded the proposed system has good potential for promoting food class and macro-nutrient education among children. This research presents an innovative use of existing AI services helping to communicate food intake related information in nutrition education. Our future work will conduct user evaluation, integrate expert and user evaluations to improve app experience and usage, and enhance system functionality.

Keywords: Doodle · Food portion communication · Machine learning · Nutrition education · Mobile application · AutoDraw · Design innovation

1 Introduction

Online experimental services based on machine learning (ML) [1–3] have been demonstrated for the recognition and mimicking of hand drawing [4–6]. These services explore possibility of using ML techniques to enhance everyday human activities.

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In this paper, we aim to devise innovative applications for existing ML-based services. Examples of ML application to help users based on free-hand illustrations include recognition, guessing, and continuous drawing. Two examples, i.e., AutoDraw and Quickdraw, as part of a suite of online ML-services were developed by Google Creative Lab [3]. AutoDraw is a drawing tool which helps users quickly and easily create visual images through integrating the user's free-hand drawings (i.e., doodles) with clip art menus [4]. And, Quickdraw [5] is a game by asking the user to draw a pre-defined object (e.g., "oven"). The game engine continuously guesses the content of the drawing until it guesses correctly or a timeout threshold is reached. These services explore possibility of using ML techniques [7] to enhance everyday human activities. In this paper, instead of striving for algorithm efficiency, we focus on investigating the potential application. We explore new utilizations based on the idea of user doodles for communication and reporting of dietary intake in the domain of nutrition education. Further, we developed an app prototype.

This research proposes a systematic approach to recognize user doodles and convert them into a standard representation using the concept of visual clips. This approach is used to develop a mobile application, named DoodleCar (Doodle Calorie), which allows the user to make a free-hand sketch to depict food portion size. The prototype app is investigated through expert evaluation.

2 Conceptual Model of the Value-Added Application

The conceptual design of our value added application has three steps: ML-based doodle recognition analysis, design transformation, and validation. In the ML recognition step, the doodle is recognized by machines and then returns possible suggestions. The recognized objects are listed with similarity scores in descent order taken from machines. The existing application, AutoDraw, is abstracted in terms of input doodles and its respective recognized output visual clips. The input-output abstraction is the result of this step that is considered as a backward thinking and is used for further design transformation.

In the transformation step, the input-output abstraction is based on forward thinking and is converted into new areas. In this paper, we transform existing application into nutritional domain that provides the user with a set of standard nutritional clips. The result of this step is that the original visual clip is converted into the nutritional clips. Typically, these clips are described in terms of processed (e.g., cooked, chopped), appearance or key features, with/without containers, or with/without scale for size. For example, an apple clip can be described based on its appearance, an appearance with an internal nucleus, peeled or chopped pieces in a bowl.

In the validation step, lead users or experts are included to participant the transformed design and provide further iterative improvement. In our study, dietitians participate to experience the functional prototype. The outcome in this step will be utilized for further system improvement.

3 System Architecture and Design

DoodleCar (Fig. 1) consists of five major components. Doodle Board provides a space for finger-sketching. Food Lister displays a list of the standard illustrations from the Food Database, selected according to suggestions from the AutoDraw Service neural network model. The Portion Board component allows users to hand gestures to describe food portion sizes. Calorie Calculator calculates the caloric value based on the input food portion from the Portion Board component and calorie data from Food Database. The calculated result is sent to the Calorie View component to display the caloric data.

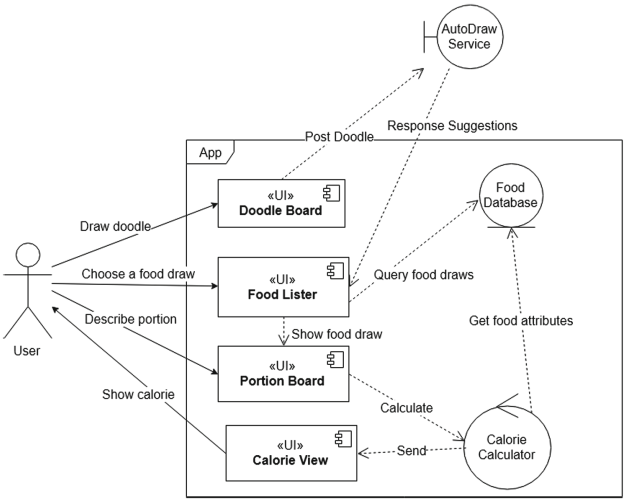
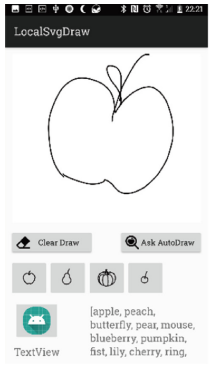
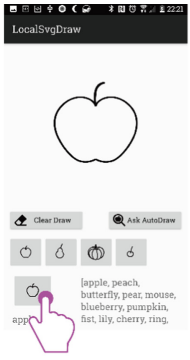


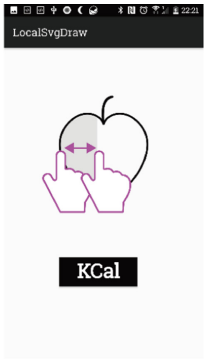
Fig. 1. System components



(a) Doodle a food item



(b) Select a desired clip



(c) Scroll to indicate portion

Fig. 2. DoodleCar demonstration

Figure 1 illustrates the process by which the system obtains suggestions. First, the user draws a doodle, from which DoodleCar extracts a point dataset through its application interface, i.e., the RESTful API provided by AutoDraw using Google's neural network model [8, 9]. A list of suggested matches is returned, which is then parsed into separate texts, e.g., apple, cherry, cup, etc., with corresponding SVG art clips. Each suggestion can have one or more art clips. The paired SVG drawing is queried in the Food Database. The mapped SVGs were sourced from a food clip art database, though some of the nutritional clips are similar to the AutoDraw art clips. Once a matched is identified, DoodleCar presents an iconic representation of the item that matches the user's doodle. The user selects a matching illustration or redraws the doodle to obtain new suggestions showed.

As for calorie calculation process, the user chooses an illustration which matches the food item and makes a hand gesture to describe the corresponding portion size, which is then used by DoodleCar to calculate the caloric content using data from the Food Database based on proportional size recognition or pixel count. The database provides corresponding caloric data for each nutritional clip. Allowing for the user to determine the caloric content of the food item and the indicated portion size along with the corresponding macro nutrient information. The calorie content is then shown in the interface.

In DoodleCar, the user draws a doodle to represents a specific food object (Fig. 2(a)). The system matches the doodle to a list of illustrations of various food items. Once a representative food illustration is selected (Fig. 2(b)), the user describes the portion size by shading the appropriate area by scrolling. The user then selects the matching food art clip for further food portion manipulation to obtain a more precise estimate of caloric and nutritional intake. Intuitive hand gestures are used to indicate portion size. Given the food item and portion size, the App calculates caloric content based on information taken from the food database.

4 Expert Evaluation

Three senior dietitians were asked to review the DoodleCar system prototype and participate in focus group discussions with the help of two research assistants at Chang Gung Memorial Hospital, Linkou, Taiwan. The working prototype was developed using Java and Kotlin with Google AutoDraw, testing on three smartphones with 7-inch display running the Android OS. After the research assistants had demonstrated the app, the dieticians were asked to use DoodleCar to draw the following sequence of food items, along with a description of a pre-determined food portion: apple, lemon, cherry, pizza, toast, noodles, carrot, and steak. The research assistants provided suggestions to refine the dieticians' doodles to ensure system recognition. After using the system for about 15 min, the dieticians participated in a focus group discussion in which the two assistants posed semi-structured questions to solicit the respondents' views on potential target groups for the app, potential supporting activities for nutrition education, and redesign recommendations. The conversations lasted about 45 min and were digitally record, producing raw transcription data for further analysis.

Analysis proceeded using affinity diagramming [10], with one research assistant producing a verbatim transcript which was then analyzed for potential categories. The other research assistant reviewed the results and challenged the presented thematic analyses and interpretation to achieve consensus for potential targets, supporting activities, and functional enhancement for the current app. The cluster of individual responses was remarked, and themed. The cumulative number of dietitians' response was counted.

5 The Result

Table 1 summarizes the remarks and suggestions from the focus group. In terms of potential target users, the three dietitians suggested the app is suitable for use by children, particularly in promoting nutrition education in terms of macronutrients and food groups. However, they raised concerns that certain users might have difficulty in drawing which might hinder their willingness to use the system. As for functionality supporting related activities, they also noted that doodles are unsuitable for describing certain categories of food items, such as vegetables, oil and fat. Responding dietitians also suggested that food portion determination could be useful, but that such functionality would require additional system improvements. Further improvements are

Table 1. Summarized expert evaluation

Viewpoint	Theme	Remark	Count
Target group	It would be ideal for children but not for those who have difficulty drawing	• Potential for promoting children's understanding of macronutrients and food classes	3
		• Not applicable for those who have difficulty drawing	1
Supporting activities	a. Doodles not well suited for describing certain food categories	• Has potential for supporting nutrition education	2
		• Not applicable for some food groups which are difficult to draw, e.g., vegetables, oils and fats	3
	b. Additional system improvements needed to allow for dietary recording	• Requires proper portion size description	1
		• Some ingredients are hard to describe and require expert support	1
		• Current design difficult to use for dietary recording	1
Additional system improvements	Other possible improvements for dietary recording include voice- or photo-based input, combined with current food portion description functionality	• Combine food photos with food portion description	1
		• Combine voice-input with current food portion description	2

required to correctly describe food portion sizes and provide complete and convenient dietary intake recording. They also noted that the app requires reliable wireless internet connectivity, and a workaround may be needed for offline use.

6 Discussion

This research presents an innovative use of existing AI services helping to communicate food intake related information in nutrition education. We propose a way of helping to address or communicate food intake by using ML techniques to recognize and analyze the content of doodles. The expert evaluation concluded the proposed system potentially promoting food class and macro-nutrient education among children. ML can provide real-time reactions through doodles instead of static illustrations, making system usage engaging and more individually interactive for learning by children. However, doodle-based input may not be appropriate for the seniors or those who have trouble with freehand drawing. In addition, some food groups are difficult to draw. Potential solutions include additional user training, or alternative input methods such as voice input. Moreover, the experts suggested that the doodle-based input might not be appropriate and require the integration of other ML techniques, e.g., voice- or visual-based inputs. In addition, a workaround is needed to allow the system to function offline. Visual aids (e.g., pictograms, images and icons) have been widely used to enhance food communication [11], and food portion pictograms to enhance intake assessment accuracy [12], or education [13]. However, few attempts have been made to use free-hand user illustrations (i.e., "doodles") as system input. Doodles might be fraught with several shortcomings (e.g., not applicable for older people, or failure to capture foods like oils and fats). Therefore, the current system would need to enhance its functionality in recognizing doodles for a specific user or in using symbols, icons, or characters to represent foods or macronutrients. Broader AI applications could also be including, e.g., doodling portion size, or foods with food containers/utensils. Future work will conduct user evaluation, integrate expert and user evaluations to improve app experience, system functionality and robustness, and broader target user group.

7 Conclusion

This paper presents an ML-based food related doodle app in health management. The app, based on the proposed system architecture, is implemented and is evaluated by three experts. The app has it feature of taking user doodles of food items as input, along with intuitive hand gestures to indicate portion size to calculate caloric intake. The expert evaluation identified system potential for promoting nutrition education among children. Future work will seek to enhance system functionality and ease of use.

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Quantitative Methods for Assessing Functional Reserves in Predicting the Effectiveness of Medical Rehabilitation of Patients with Diabetes

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Abstract. New diagnostic directions in rehabilitation and expert diagnostics consist in assessing the safety and the possibility of restoring (in whole or in part) the operation of the patient's systems, using the extra-nosological approach to assessing function at the level of the whole organism. The data on the quantitative assessment of the functional reserves of the body (adaptive potential) in 139 patients with type 2 diabetes was presented. The prospects of using this indicator in predicting the effectiveness of rehabilitation are studied.

Keywords: Functional reserves · Adaptive potential · Diabetes · Quantitative methods

1 Introduction

The development of digital healthcare requires increasing the speed of screening of the patient's condition, processing, transmission and output of information, developing new diagnostic directions. Consideration of the adaptive capabilities of the body as a new risk factor in assessing the patient's condition and predicting outcomes is an important component for an individualized approach to patient.

2 Purpose

Quantitative assessment of adaptive reserves in predicting the effectiveness of medical rehabilitation in patients with type 2 diabetes mellitus (T2DM).

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3 Materials and Methods

139 patients T2DM, 48 ± 6.1y were included. The study was conducted in City Hospital. A.K. Eramishantseva (Moscow), Clinical Hospital of the Udmurt Republic (Izhevsk), FB MSE (Izhevsk). The ethic norms confirmed by Ethics Committee of RUDN University (Protocol №. 8 of February 18, 2016) and Izhevsk Medical Academy (Protocol №. 8 February 18, 2010).

The study of the adaptive reserves (AR) carried out by morphofunctional index - MFI [1] with automated data assessment [2]. The essence of the invention: actual parameters of functioning of the patient's cardiovascular system evaluated and similar indicators calculated for situation if patient's body was in perfect (healthy) condition. MFI formula obtained by computer simulation. MFI assessing degree of deviation of actual data from ideal data in particular patient. MFI "−1.0" to "0" - functioning of the body was not impaired, level of MFI - "0" to "1.0" - functioning is compensated by its own functional reserves or medication correction, MFI more than "1.0" - functioning is disrupted, the body's own reserves are depleted, and medications don't fully compensate. As higher this indicator is as lower the level of AR.

4 Results

The patients were given medical rehabilitation program. MFI in patients decreased, but target values for glycemia achieved in 67%. The adequacy of the rehabilitation measures wasn't enough for good effect at all patients. We identified group of patients (17 individuals) who, despite a positive attitude and close monitoring of diabetes, complications progressed and found that these were patients with MFI > 3.0. During the rehabilitation process, MFI decreased, but not less 2 points. All patients with MFI > 1.0 were included in the group with an unfavorable clinical prognosis. In patients of this group disability developed in 88%. The correlation between MFI and rehabilitation prognosis (favorable, doubtful, unfavorable) turned out to be high ($r = 0.71$), which allowed us to assess the prospects of medical rehabilitation measures and restoration of the ability to work.

The method validated by comparing the values of MFI and rehabilitation potential (RP) established of specialists FB MSE UR team. The analysis showed an even higher correlation $r = 0.81$ between the values of MFI and RP. 79 patients examined (study was in 2010), 7 conclusions didn't coincide (8.9%). Each case examined individually. In more than half of cases, MFI was more accurate.

5 Conclusion

Decreased AR is new risk factor. The calculation of MFI for each specific observation allows evaluating clinical prognosis, effectiveness and adequacy of the ongoing rehabilitation measures.

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Effects of the Physical Therapy Application for Elderly

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Abstract. Currently, the number of elderly is continuously increasing and by 2020 in Thailand, the population of 60 years is one in six of the total population. Therefore, encouraging the elderly to take care of themselves will help make them live longer and have a good quality of life. Physical therapy is a method of treating the abnormal movement of the body and it must be performed regularly in order for the body to be continuously refreshed. Often, the elderly do not receive proper physical therapy due to travel difficulties and high cost of treatment. Hence, this research studied the possibility of using Kinect technology in the physical therapy program to help the physiotherapist properly. This study was quasi-experimental research using simple random sampling. All participants were interviewed for their demographic information and examined according to the five-arm muscle exercises. The results of the motion detection experiment using the Kinect camera and the experimental physical therapy program using the Kinect device show that Kinect can detect the movement very well and physiotherapy programs with Kinect devices help users perform more accurate physiotherapy compared to doing physical therapy. The data were analyzed by the mean, standard deviation. The results meant that physical therapy Application based on Kinect for Elderly could improve physical fitness and they have a positive effect on balance and thus on the quality of life.

Keywords: Physical therapy · Application · Elderly · Kinect · Effects

1 Introduction

Currently, the number of elderly people is increasing and by 2020, there will be a large population aged 60 years, which is 1 in 6 of the total Thai population. Therefore, encouraging the elderly to take care of themselves will help make them live longer and reduce the burden of expenses in caring for illness. The physical and health changes with aging causing the body to lose physical performance like loss of muscle velocity, balance, and agility strength. The elder face problems in many aspects of their lives. Low mobility results in pathologic aging changes to organs in various systems more easily, such as joint pain, osteoarthritis, bone decay, respiratory disease due to impaired lung function coronary artery disease Stroke and high blood pressure.

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Rehabilitation of the elderly by exercising is an activity that can prevent, care, treat the elderly, and reduce health care expenses. Physical Therapy is a science that restores health by exercising and using special equipment to treat patients to return to normal movement as much as possible and physical therapy in the prevention, treatment, and management of abnormal movement caused by the condition of the disease that can occur at any age especially the elderly. Furthermore, Physical therapy will help strengthen the body and prevent injury, which causes the body to become impaired in movement.

Information technology is progressing and growing rapidly and the development of tools and equipment for motion capture are tools that are widely used. Kinect is a line of motion sensing input devices [1] and it is an accessory to the Xbox 360 game console. Kinect can detect players' bodies and be able to classify the position of various joints of the player's body. Therefore, this research applied the ability of Kinect used in the exercise of the elderly.

2 System Development

This project is an experimental study to test the program with the elderly by focusing on the efficiency of the developed system and the detection accuracy of the user gestures. Hence, it needs to study information from various sources and related research to apply in the Physical therapy application with Kinect equipment. The literature review revealed the significant findings of using Kinect in elderly care as follows. Lange et al. [2] proposed the game for practicing neurological balance by using Kinect to detect patient movements and used the detection data movement that had to control the cartoon characters in the game and the results demonstrated the game helped to develop the balance of patients with pleasure and the patients were very satisfied. Using the Kinect sensor, the system captured limb node data and detected incorrect postures with DTW algorithm and the result was 95.20% [3]. Liu et al. [4] have proposed methods for detecting motion-free marking at various locations on the body of user motion detection. This research could separate the layout of two users by using the Image Segmentation method to perform surface estimation and create a three-dimensional model. To determine the position on the detection area, a global coordinate system (GCS) was used to identify the vector coordinates (x, y, and z) of the Kinect cameras from the point of direction. The experiment was performed with the participants standing at a distance of 2 meters to detect the physical therapy as shown in Fig. 1.

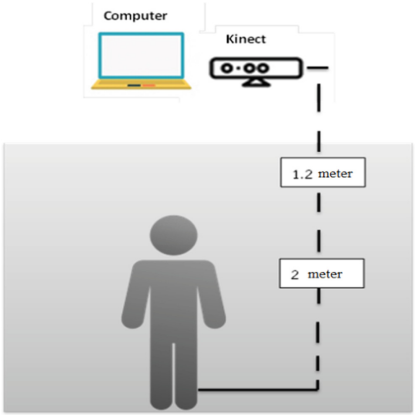

Fig. 1. The location of the motion detector

From studies and interviews with experts, the researchers gather requirements, design, and scope of work, as shown in Fig. 2. Figure 2 was described the system's operation, which consists of 3 parts: how to play, play and score and statistics. Users can choose physical poses and when finished, the system keeps score and the times of doing exercises. Users can check previous scores from the statistics menu. Figure 3 was displayed the user interface and example of the application.

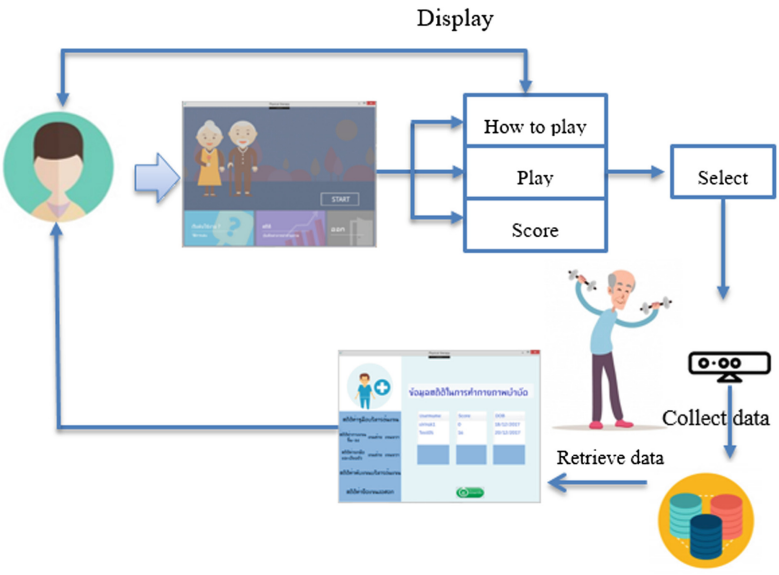

Fig. 2. System design

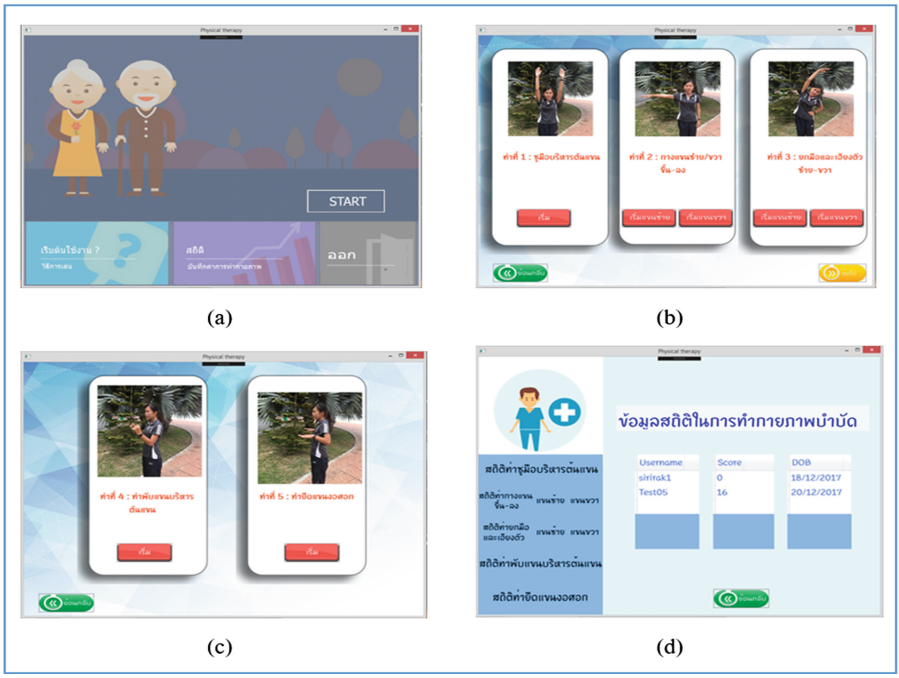

Fig. 3. The user interface design

3 Results

This section shows the results of the program experiment as the following this: Black Box testing approach was applied to evaluate this project because this technique assesses the performance of project without paying attention to how the system works and what it does but it will test only the input and output without checking how the system will process it. Black Box testing is determined the error of the project as following: functional requirement test, Function test, Usability test, Performance test and Security test [5] (Table 1).

Table 1. The results of Black Box testing approach

	Level of proficiency (n = 5)		
	$\bar{X}$	SD	Result
1. Assessment of the functional requirement test	4.00	0.39	Highest level
2. Assessment of the functional test	4.00	0.47	Highest level
3. Assessment of the usability test	4.01	0.61	Highest level
4. Assessment of the performance test	4.55	0.15	Highest level
5. Assessment of the security test	4.50	0.21	Highest level

In addition, the system is used to test the 10 elderly people aged between 55 and 70 years old. The Table 2 was presented the results of the motion-detecting activity in all 5 postures in physical therapy, performed all 5 postures, showed that the accuracy was high in the positions and the highest error detection was the 4th position: folded arms and upper arm management. This is caused by a mistake in specifying the joint position of the arms on both sides, as well as the movement of the body, so the position of the joints have as little changed. However, there are many factors that caused to be fewer mistakes in detection like the speed of posture, physiotherapy, and detection of joints.

Table 2. The results of the motion detection experiment in physical therapy posture

Users	The performance of the correct posture (10 times per person)				
	Posture no. 1	Posture no. 2	Posture no. 1	Posture no. 4	Posture no. 5
1	10	10	9	9	8
2	10	9	9	8	9
3	10	10	9	9	9
4	10	9	9	9	10
5	10	10	10	7	9
6	10	9	9	7	9
7	10	10	9	7	8
8	10	10	9	8	10
9	10	9	10	9	9
10	10	10	9	7	10

The results showed that the performance of the correct posture was good and users were satisfied when playing this application (Fig. 4).

Fig. 4. The example of participants playing this application

4 Conclusion

The exercise of the elderly helps to slow the deterioration of the various systems also improves the strength of muscles. Hence, the significant objective of this project has been to implement the physical therapy application based Kinect for elderly persons. From the development of the physical therapy application using Kinect, the results of this project can help elderly people in physical therapy and the system consists of five physiotherapy postures and haves videos showing how to do it easily. Users were satisfied with the application at a good level however the limitation of this project found that when the subject's body is obscured by another object, the API is unable to determine the correct position of the joint position and the result may be incorrect. In addition, the quality of the coordinate data of the joints received from the API is unstable, so it is not possible to specify the location, including calculating degrees or measuring distances. In the future, researchers will focus on the constraints and the requirements to study other factors like the feasibility of using the position that affects the level of accuracy in detecting.

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Probiotic Lactic Acid Bacteria Isolation from Fermented Beef (Naem) Samples for Use as Starter Culture

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Abstract. The objective of this research is to isolate strains of probiotic lactic acid bacteria from beef fermented samples. The probiotic lactic acid bacteria has the ability to inhibit microorganisms that cause food poisoning. The use of probiotic lactic acid bacteria as a starter for Naem production will increase food safety. From the experiment, 18 isolates of lactic acid bacteria were isolated and only 4 isolates, A2, A3, A4, A11 and B3, were able to create amino acid decarboxylase which can convert amino acids into biochemical amines. After testing the inhibit pathogenic bacteria ability, it was found that all 18 isolates were able to inhibit the testing gram positive food poisoning bacteria, *Bacillus cereus*, *Staphylococcus aureus* and *Pseudomonas aeruginosa*. 6 isolates which could inhibit *Esherichia coli* were A1, A3, A6, A8, B1 and B7. 10 isolates that could inhibit *Salmonella* sp. were A1, A2, A3, A4, A7, A8, A10, A11, B2, and B7. 7 isolates that could inhibit *Shigella flexneri* were A1, A2, A3, A6, A11, B2, and B7. Heat resistance was tested at 65 °C for 1 h. It was found that the number of all isolates were reduced by 2–3 log CFU/ml. The survival tests of the 18 isolates in the digestive system were done. It was found that all 18 isolates were able to withstand acidic conditions from stomach enzymes and bile, with small decrease of bacteria number after 2 h of testing. Therefore, it can concluded that the isolated lactic acid bacteria are suitable to use as starter cultures in Naem production.

Keywords: Fermented beef · Isolation · Probiotic

1 Introduction

Naem (pronounced [nĕ:m]) [1] is sausage in Thai and Southeast Asian cuisine. It is usually make from pork but also use other kinds of meat as raw material. It is a sour flavor fermented food obtained from natural fermentation. It has short shelf life. It is often eaten in raw form after the fermentation process. It is also used as an ingredient in various dishes. Microbes that play an important role in the production are lactic acid bacteria but, normally, the fermentation process relies on microbes contained in ingredients such as meat, glutinous rice, as well as equipment, containers, and environment. This makes its inability to control the type and amount of microbes that cause good quality fermentation. It often encounters various problems in production, such as

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unstable quality of product and be contaminated by pathogenic microbes. Although lactic acid, form during fermentation, can inhibit the growth of some pathogenic bacteria but parasites and enteropathogenic bacteria still have been found in samples of Naem.

Lactic Acid Bacteria (LAB) is gram-positive bacteria that play an important role in fermented food products. Most of them have been selected to be safe GRAS microbes (Generally Recognized as Safe) [2] and used as a starter in various fermented food industries such as cheese, yogurt, sausage, pickled fruits and etc. [3]. LAB produce metabolic substances such as organic acid, ethanol, diacetyl, hydrogen peroxide, and bacidiolin (bacteriocin) which has ability to inhibit food poisoning microbes that may contaminate during the production process, such as *S. aureus* and *E. coli* [4]. Lactic acid bacteria been studied extensively in the use of biological preservation because consumers are more caring for their health. They pay attention to quality and safety in consumption [5]. Therefore, the selection of lactic acid bacteria from Naem using beef as raw material is a way to find strains with probiotic properties which can inhibit the growth of microorganisms that cause food poisoning. It, also, have heat resistance properties and able to survive in the digestive system. The lactic acid bacteria can be used as a starter for the production of Naem from beef which can be halal food for Islamic consumers.

2 Method

1. Collected 10 samples of Beef Naem beef from the market, then sampling 25 g per sample.
2. Add the sampling to 225 ml of 0.85% sodium chloride solution and mix with vortex mixture.
3. Dilute by 10 fold-serial dilution method with 0.85% sodium chloride solution and pour plate the dilution in MRS agar (De Man, Rogosa and Sharpe agar), which added 0.004% Bromcresol purple as indicator.
4. Incubate in a candle jar at 37 °C for 24–48 h.
5. Check the color change of indicator. Select microorganisms that change the color of culture medium from purple to yellow.
6. Check the morphology and basic properties of lactic acid bacteria
   - 6.1 Pick colonies from 5 and do gram staining. Examine the finished slide under a microscope.
   - 6.2 Catalase enzyme test by put 1–2 drops of 3% hydrogen peroxide on bacterial colony on slide.
7. Amino acid decarboxylase production test
   - 7.1 Culture the isolated lactic acid bacteria from 6 in Brain Heart Infusion Broth with 0.1% of each amino acid substrate (Tyrosine free base, Histidine monohydrochloride, Ornithine monohydrochloride and Lysine monohydrochloride). Then add Pyridoxal-5-phosphate.
   - 7.2 Add a drop of each lactic acid bacteria solution from 8.1 to the solid media contain the same amino acid substrate. Incubate at 37 °C for 4 days.

7.3 If purple color occurs around the colonies or precipitate of the amino acid precursors around the colonies fade away, amino acid decarboxylase production is positive.

8. Bacteriocin production test by agar spot method.
9. Heat resistance ability test
   9.1 Culture lactic acid bacteria in TSBYE (Tryptic soy broth with yeast extract) culture media. Incubate at 37 °C for 24 h. After complete incubation, transfer 0.5 ml to new TSBYE tubes, incubate at 37 °C for 24 h.
   9.2 Centrifuge at 5,000 rpm for 15 min.
   9.3 Resuspend with 10 ml of Sterile Quarter Strength Ringer's solution and adjust the initial concentration to 10^9 CFU/mL.
   9.4 Transfer 0.5 ml of the culture solution from 10.3 to the 49.5 ml of buffered peptone water flask (the concentration of culture is 10^7 CFU/mL).
   9.5 Soak flask at 65 and 37 °C in water bath and count the number of bacteria at 0, 5, 10, 15, 20, 30, 40, 50 and 60 min. Test set at 37 °C is control set.
10. Survival test of lactic acid bacteria in gastrointestinal simulation
   10.1 Inoculums are prepare the same as 10.1–10.4
   10.2 Adjust the pH to 2.5 with 1 M HCl and add 1000 unit/mL of pepsin.
   10.3 Incubate at 37 °C. Count the number of bacteria at 0, 30, 60 and 120 min
   10.4 At the end of each times, adjust to pH 7 with 1 M NaOH and add 0.3% bile salt (w/v). Incubate at 37 °C and count the number of germs at 0, 30, 60 and 120 min. Record the results.

3 Experimental Result

3.1 Lactic Acid Bacteria Screening

Screening lactic acid bacteria from beef Naem samples which sampling from local market by

1. Select yellow colony with clear zone on MRS with calcium carbonate agar.
2. Morphology examine with a microscope.
3. Negative catalase production testing.
4. Gram positive.

18 isolates of microorganisms with the above characteristics are isolated.

3.2 Amino Acid Decarboxylase Production

Examination results found that

- None produced tyramine.
- A2, A3, A4, A11 and B3, were able to create amino acid decarboxylase (Fig. 1).
- Isolates A3, A4 and B3 produced histamine.
- A2, A4 and A11produced putrescine.
- A2 and A4 produced cadaverine.

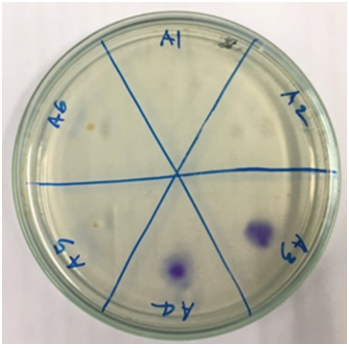

Fig. 1. Positive result of amino acid decarboxylase production (purple color)

3.3 Pathogenic Inhibitors Production

Test the ability of the production of pathogenic inhibitors by agar spot method and select the isolate with positive results to compare the effectiveness of the inhibitors by Agar well diffusion method. Test results as in Tables 1 and 2.

Table 1. The ability to produce Gram-positive pathogenic bacteria inhibitors of lactic acid bacteria isolate using agar spot method.

Isolates	*Bacillus cereus*	*Staphylococcus aureus*	*Pseudomonas aeruginosa*
A1	+	+	+
A2	+	+	+
A3	+	+	+
A4	+	+	+
A5	+	+	+
A6	+	+	+
A7	+	+	+
A8	+	+	+
A9	−	−	−
A10	+	+	+
A11	+	+	+
B1	+	+	+
B2	+	+	+
B3	+	+	+
B4	−	−	−
B5	−	−	−
B6	−	−	−
B7	+	+	+

+ = have clear zone
− = not have clear zone

Table 2. The ability to produce Gram-negative pathogenic bacteria inhibitors of lactic acid bacteria isolate using agar spot method.

Isolates	*Esherichia col*	*Klebsiella pneumoniae*	*Salmonella*	*Shigella flexneri*
A1	+	+	+	+
A2	−	+	+	+
A3	+	+	+	+
A4	−	+	+	−
A5	−	+	−	−
A6	+	+	−	+
A7	−	+	+	−
A8	+	+	+	−
A9	−	−	−	−
A10	−	+	+	−
A11	−	+	+	+
B1	+	+	−	−
B2	−	+	+	+
B3	−	+	−	−
B4	−	−	−	−
B5	−	−	−	−
B6	−	−	−	−
B7	+	+	+	+

+ = have clear zone
− = not have clear zone

The isolates that can created the maximum inhibitory area of B. cereus is B7. The isolates that can created the maximum inhibitory area of *S. aureus* are B2 and B7. The isolates that can created the maximum inhibitory area of *P. aeruginosa* is B7. The isolates that can created the maximum inhibitory area of *K. pneumoniae* is A3. The isolates that can created the maximum inhibitory area of *E. coli* is B7. The isolates that can created the maximum inhibitory area of *Salmonella* sp. is A1. The isolates that can created the maximum inhibitory area of *Shigella flexneri* is B7.

3.4 Heat Resistance Test

The results of the heat resistance test of all 14 isolates, which can produce pathogenic inhibitor, show that number reduced only 1–2 log from the test using the temperature at 65 °C for 1 h.

3.5 Survivability of Lactic Acid Bacteria in Digestive System Simulations

From the survival test of lactic acid bacteria in gastrointestinal simulation, it was found that lactic acid bacteria were able to withstand acidity at pH 2.5 as well. Every isolate has only a small amount of bacteria decrease. The number of bacteria remained the same or only slightly decreased after 0.3% bile salt tolerance test for 2 h.

4 The Conclusions

In this research, 18 colonies of lactic acid bacteria were isolated from beef Naem samples. Some isolates produced histamine, putrescine and cadaverine. These substances are biogenic amine which can cause illness. However, healthy people are able to degrade the small amount of these agents.

After that, the tests of the ability of pathogenic bacteria inhibitor production were tested. The results show that most of the isolated can inhibit the growth of pathogenic bacteria. So that, the use of lactic acid bacteria as the starter in Naem production will make the better competition with other contaminate microbes. In addition to bacteriocin-forming properties, lactic acid bacteria also produce organic acids and hydrogen peroxide that help stop microbes.

Heat resistance of the lactic acid bacteria was also tested at 65 °C for 1 h. The isolated lactic acid bacteria have heat resistance properties. Even though Naem is heated by various processes, consumers still get large numbers of lactic acid bacteria with probiotic properties. Result of survive in gastrointestinal simulation test show that the isolate lactic acid bacteria can survive for at least 2 h. This indicate that microbes can be left to reach the large intestine. This is good for health caring. However, Nham production should be further experimented with sensory evaluation.

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The Human Interface Interaction Design Based on Blood Oxygen Meter

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Abstract. Health has always been the focus of human's attention, however there is not enough research about home medical device interfaces. This paper aims to discover the key principles and perceptual demands that should be taken into consideration when designing a oximeter interface. The concept of 'human-centered' is not only for the product design, but also for the interface design. Compared with normal people, patients need more emotional supports from the products they used. In the second part, Kansei engineering is used to discover these emotional needs. Using these Kansei words can guide the next iterative interface of oximeter. In the third part, aesthetic evaluation is proposed in order to choose the best interface among the three optimized interfaces which put forward in part two. Balance, sequence and cohesion are the three calculation indexes. The result of this paper has a great influence on a human oriented interface design.

Keywords: Oximeter interface · Kansei engineering · Aesthetic evaluation · Human factors · Medical appliance

1 Introduction

In the twenty-first century, the pace of human's life is speeding up, as well as the pressure of human's work is getting higher, causing a lot of problems in people's health condition. The traditional medical treatment is facing a revolution because of the convenience and efficiency of home medical devices. With the development of Internet of things (IoT) technology, home medical assistants have become more and more powerful and popular among common families. It is believed that with wearable medical devices, diseases can be detected and found quickly in daily life. This device enable the patients to notice when they are in critical condition [1]. From hundreds of home medical devices, the pulse oximeter has been demonstrated to be the best medical instrument which used to monitor human' arterial oxygen saturation and pulse rate [2]. A pulse oximeter is a non-invasive home medical appliance, the work principle of it is using red and infrared light. These two kinds of lights can penetrate the tissue of human. Through measuring the transmitted light penetration from source to receiver, which are placed on the opposite sides of the oximeter, the numerical values of arterial oxygen saturation and pulse rate are shown on the embedded electronic screen [3]. They are the two key physiological indicators that can evaluate the real-time health condition assessment of human.

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Fig. 1. The common type of an oximeter which people can find in market.

Figure 1 depicts the finger oximeter design for home healthcare consisting of lots of sensors and an embedded screen. The data on the screen is not easy to distinguish from different health indicators and the arrangement of elements and layout ignore patient's emotion and user experience. Home medical devices have broad market prospects, however the related research for human-centered interface of oximeters is not enough. Based on previous interface, Kansei engineering and aesthetics evaluation are chosen to measure the ergonomics of the three new pulse oximeter interfaces which put forward in this paper. This analysis result provides a valuable reference to enhance the usability and the flexibility of the next iteration of the pulse oximeter prototype.

2 Kansei Engineering

2.1 Theory and Method

Human factors focus on human and the interaction between human and products [4]. A good design is a combination of human, product, environment, economic and technology [5]. Interface is a bridge of information communication between human and product, therefore human factors should be considered in order to enhance the effectiveness of product and achieve certain desirable human values. For hundreds of years, lots of scientists have been trying to answer what element has an effect on human's emotion. Kansei engineering is one of these representative theories. It was first put forward by Yamamoto, the former president of Mazda motor corporation [6]. This theory transforms ambiguous emotional demands to a certain design point which can be adopted into a product design, and has the guiding significance of exploring the relevance between human's emotion and product design characters [7]. Kansei engineering has been applied in many research areas, such as automatic digital mood boards, city public environment facilities and automotive interior design [8–10]. As a home medical product, perceptual demands should be taken into consideration when designing the interface of an oximeter to relieve the anxiety of a patient. Through the Kansei words analysis, certain emotional requirements can be extracted to help researchers optimize the oximeter interface. Figure 2 shows the Kansei engineering procedure analysis in this part.

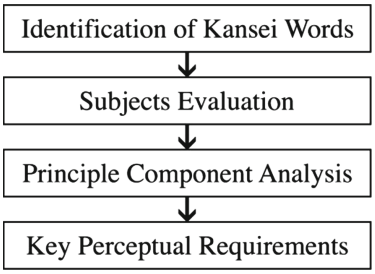

Fig. 2. Research procedure and frame of Kansei engineering

Ten Kansei words were selected based on the design trends of interfaces and medical devices. Twenty subjects who have used an oximeter at home before were invited to participate in this research. Using Semantic Differential scale, they need to fill in the blanks of a Kansei words list and mark the objects in a range from 1–10 point to measure their perceptual evaluation of the medical product interface. During the scoring process, discussion is not allowed. Principal component analysis was performed among these data to find the key Kansei words in determining an oximeter interface design. The analysis was calculated by SPSS, a statistical software product that can assist researches to do some mathematical analysis based on the data obtained from the experiment.

2.2 Result and Discussion

After finishing the principle component analysis, the result is shown as Table 1. 'Positive', 'Scientific' and 'Warm' obtained the highest scored in factor1, which means they have the greatest impact on an oximeter interface design meet a patient's special emotional requirement.

Table 1. Principal component analysis

Kansei words	Component	
	Factor1	Factor2
Positive	.769	.332
Scientific	.733	.112
Warm	.690	−.207
Simple	−.021	.822
Cute	−.187	.742
Smooth	.215	.593
Colorful	−.163	−.353
Modern	−.471	.294
Unique	.297	−.254
Dynamic	.231	−.037

Patients are more sensitive to products than common people and need obtain emotional strength from the products that they use. Based on this result, three optimized oximeter interfaces are proposed as Fig. 3, using Kansei words positive, scientific and warm. The screen size is 28 mm (width) and 40 mm (height).

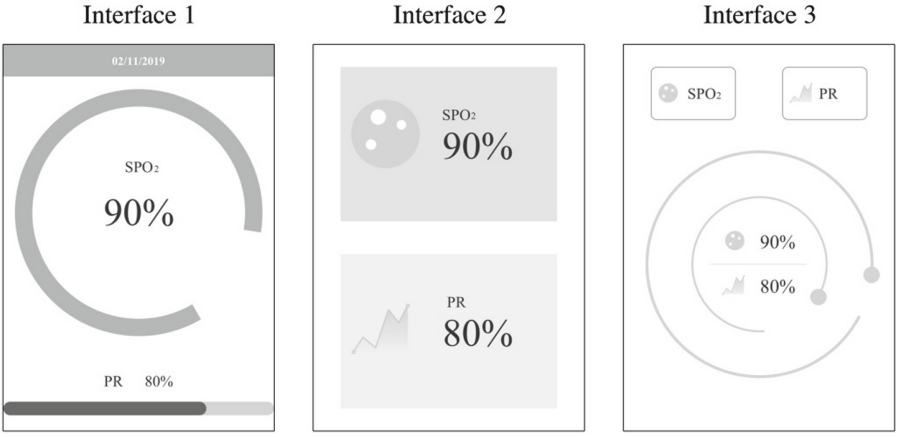

Fig. 3. Optimized oximeter interfaces based on Kansei words

3 Aesthetic Evaluation

In addition to emotional demands, another important aspect of oximeter interface design is aesthetic. High correlations were found between interface aesthetics and usability, and interface aesthetics has an effect on comprehensibility as well [11, 12]. Therefore, it supposed that elements layout has some relationships with people's emotion and the main purpose in this part is to discover the ambiguous standards. Since in the age of print, human have the spirit of pursuing beauty. However, it is not easy to distinguish beauty from ugly. The aesthetic standards confused researchers for a long time. Balance, symmetry and sequence are the common design techniques that used by many graphic designers. They are related to interface design as well. Ngo, Teo and Byrne proposed twelve equations of the quantitative analysis in interface aesthetics [13]. In this part, three equations will be selected to assess the oximeter interface for choosing the best one. To simplify the calculation, all the elements are regarded as squares. The equations focus on the perception of structure created by spacing, not on single words.

3.1 Balance

Balance refers to the object are in an interface. Human have the perception that larger objects are heavier than small objects, which is called optical weight. The screen is divided into four parts, upper-left, upper-right, lower-left and lower right.

$$BM = 1 - \frac{|BM_V| + |BM_H|}{2}. \quad (1)$$

The calculation result of the three optimized oximeter interface is shown as Table 2.

Table 2. Computation result of balance

Interface1	Interface2	Interface3
0.84	1.00	0.99

3.2 Sequence

Sequence refers to a measurement of how information in an interface is ordered according to a reading pattern that is common in human reading habit: from upper-left to lower-right. In addition, larger elements attract human's attention and break this eye movement.

$$SQM = 1 - \frac{\sum_{j=UL,UR,LL,LR} |q_j - v_j|}{8}. \quad (2)$$

Each quadrant is given a weighting ranging from one to four. The calculation result of the three optimized oximeter interface is shown as Table 3.

Table 3. Computation result of sequence

Interface1	Interface2	Interface3
1.00	1.00	1.00

3.3 Cohesion

Similar aspect ratios contributes to cohesion. Aspect ratios means the quotient of width and height. This element also has an effect on eye movement.

$$CM = \frac{|CM_{fl}| + |CM_{lo}|}{2}. \quad (3)$$

The calculation result of the three optimized oximeter interface is shown as Table 4.

Table 4. Computation result of cohesion

Interface1	Interface2	Interface3
0.65	0.75	0.75

3.4 Result

Finally, the average of each optimized interface is calculated to find the best one with the highest aesthetic evaluation value. The result is shown in Table 5.

Table 5. Sum of aesthetic indexes

Interface1	Interface2	Interface3
2.49	2.75	2.74

The second screen gets the highest computed value and conforms to the aesthetic demand of human.

4 Conclusion

This research adopted Kansei engineering and aesthetic evaluation to analyze the most important element in an oximeter interface design based on the user's psychological commands and the desire in beauty. Through principle component analysis, positive, scientific and warm are the three key emotions that influence the design of home medical devices. Using three aesthetic calculation formula, the value of balance, sequence an cohesion of the three optimized oximeter interfaces. Finally, it can achieve the combination and balance of emotion and aesthetics. Further research will attempt to discover whether this conclusion can generalize from the oximeter to common home health devices. The aesthetic effects about colors and shapes of the elements on an interface are also need to be evaluated in additional research.

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The Display of Conformal Symmetry in Lungs Formation of Human Fetuses

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Abstract. 93 preparations of the right and left lungs of human fetuses of 13–36 weeks of development were examined and measured. We determined the length of the front and back edge of each lung and the length of its base. The three adjacent sequence numbers were interpreted as the lengths of three segments used in the formula to calculate the wurf. The average wurf quantity for each age group in prenatal period of development varies from 1,26 to 1,33 for the right lung and from 1,23 to 1,35 for the left lung. These fluctuations are within a 5% range of 1,31 – the "golden" wurf quantity. In the process of lung growth, the proportions between the length of the front edge, the length of the back edge and the length of the base vary according to the rules of conformal transformations. Changing of one number is consistent with the change of the other two so that at any given time the proportion remains the same and equals 1,31. The rule of the "golden wurf" is subject to all tripartite chains of human body, including the external structure of the heart, its chambers, the teeth of an adult, kidneys, lungs, as confirmed by our research.

Keywords: Fetus · Lung · Conformal symmetry

1 Introduction

The studying of the internal organs shaping has a big theoretical and practical significance. Due to most of the researchers, the structure of an organ is defined by its adaptation to the environmental conditions and functional load. The authors assume that there are no proper laws of morphogenesis. According to S.V. Petukhov (1,2), there are two kinds of proportions in kinematic blocks of a human body - wurf and affine - which express differently during the ontogenesis. Wurf proportions rigidly stay constant and are connected to the Fibonacci series, affine ones change during the phylogenesis. Characteristics of the kinematic scheme of the human body are defined by the presence of relatively unchanged wurf proportions in it, the size of which is defined by the phyllotaxis laws of morphogenesis and affine proportions, which when change - help the organism adapt to its lifestyle. The fact of the symmetry in the forms of biological bodies is considered as the main state about the existence of specific laws of morphogenesis.

In a variety of forms, there is an orderliness independent of the function which obeys the mathematical laws of harmony [1]. During the prenatal period of the ontogenesis, all organs and organ systems that define the development of the mechanisms of

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the adaptation to the postnatal life conditions are formed. Features of the fetus' organs and functional systems development affect the course of the neonatal period and substantially define the health status in the following life periods.

Goal: revealing the patterns of growth of linear dimensions of the human lungs during the prenatal period of the ontogenesis.

2 Materials and Methods of the Study

93 left and right human lung preparations on the 13–36th weeks of development made up the material. All the material is collected in compliance with legal and ethical standards. Length, width, front-back size of the left and right lungs were measured, the growth constant of linear dimensions of the lungs and the relative growth rate were calculated [3, 4], Wurf size was set [1, 2]. The results of the measuring were processed in the operating environment Windows of Workgroups 6.0 by the common methods of variation and alternative statistics on IDM PC/AT Pentium using a software product MicroCal Origin Version 2.94 and a spreadsheet program Microsoft@ Excel 97. For statistical processing, an inline analysis package was used applying descriptive statistics, which included the calculation of the arithmetic mean (x) and its error (± m), standard deviation (s). The reliability of intergroup differences was assessed using the student criterion with a confidence probability of 0.95.

3 Results

Data obtained by measuring the fetus's lungs are presented in Table 1. The relative growth rate allows you to set the frequency of change of the studied parameters of the biological object.

Table 1. Average values of linear dimensions of the right and left lungs by weeks of the fetal period of development (M ± m, mm).

Age (weeks)	Linear dimensions					
	Length		Width		Thickness	
	Right	Left	Right	Left	Right	Left
13–16	13,51 ± 0,70*	14,61 ± 1,04	7,33 ± 0,82	6,22 ± 0,52	16,07 ± 1,24	13,78 ± 1,19
17–20	21,43 ± 0,80*	22,80 ± 1,00	10,69 ± 0,65*	9,92 ± 0,69*	26,90 ± 0,97	24,64 ± 1,03
21–24	22,09 ± 0,58	24,21 ± 0,88	12,07 ± 0,43	11,01 ± 0,38	29,01 ± 0,69	26,55 ± 0,59
25–28	27,35 + 1,43*	28,88 + 0,73	16,06 + 0.75*	16,68 + 0,48	35,00 + 0,91	32,22 + 1,11
29–32	34,50 + 0,91*	37,47 + 0,82	17,83 + 0,88	17,73 + 0,87	36,67 + 0,82	34,83 + 0,65
33–36	41,23 + 0,82*	43,70 + 0,96	20,98 + 0,52	20,04 + 0,31	42,50 + 0,73	37,50 + 0,91

Note: when comparing data of each term with the previous one, differences are significant when $P < 0,05$.

It was revealed that the linear growth of the lungs is uneven, each of the indicators has periods of fast and slow growth. Periods of fast and slow growth do not match. For a quantitative expression of the growth rate of the lungs, in certain age periods, the growth constant was calculated by the Schmalhausen formula [4]. Growth constant of the right lung increases in 20th and 32nd weeks. From 16th till 20th weeks this number increases from 1.23 to 2.01 and from 0.12 on the 24th week to 1.60 on the 32nd week. The intensity of the length growth of the right lung increases in the 20th 28th and 36th weeks of the embryogenesis. Curves of relative lung growth rates in length width and thickness are close to hyperbole, which indicates an inversely proportional relationship between growth rate and time elapsed from the beginning of development. This dependence is one of the signs of parabolic growth. For the growth of the lobes of the same lung in length width and depth, the periods of fast and slow growth alternate. Each lobe has its inherent proportions to the parameters of the whole lung (Tables 2 and 3). An attempt to find a mathematical formula to describe the shape of the lung came down to using a geometric formula for calculating the values of the Wurf: $(a+b)\cdot(b+c)/(a+b+c)\cdot b$, where a - the length of the upper margin, b - the length of the posterior margin, c - average length of the lung base. Wurf average calculated for each age group ranges from 1.26 to 1.33 for the right lung and from 1.23 to 1.35 for the left lung (Table 4). These fluctuations occur within 5% of the size of the number 1.31 - golden wurf size. The ratio of the three linear sizes of the lungs (the length of the upper margin, the length of the posterior margin, the length of the lung base) is a relatively constant value and does not depend on age (Fig. 1).

Table 2. The average values of the linear dimensions of the lobes of the left lung by weeks of the prenatal period of development (M ± m, mm).

Age (weeks)	Upper lobe			Lower lobe		
	A	B	C	A	B	C
13–16	16,67 ± 0,45	5,11 ± 0,43	12,11 ± 0,69	13,67 ± 0,70	7,33 ± 0,46	7,22 ± 0,56
17–20	27,72 ± 0,61	7,59 ± 0,33	19,69 ± 0,55	21,77 ± 0,58	12,72 ± 0,23	12,03 ± 0,55
21–24	29,06 ± 0,22	7,62 ± 0,37	20,27 ± 0,38	23,43 ± 0,43	12,43 ± 0,64	13,60 ± 0,59
25–28	34,58 ± 0,64	9,00 ± 0,54	21,86 ± 0,32	26,65 ± 0,38	16,00 ± 0,35	15,50 ± 0,43
29–32	43,83 ± 0,34	11,63 ± 0,37	30,47 ± 0,52	29,07 ± 0,27	18,32 ± 0,71	16,80 ± 0,25
33–36	48,58 ± 0,52	16,39 ± 0,41	31,77 ± 0,27	31,53 ± 0,54	22,50 ± 0,53	18,00 ± 0,34

Note: A - the length of the lobes, B - the width of the lobes, C - the thickness of the lobes, when comparing data of each term with the previous one. Differences are significant when $P < 0.05$.

Table 3. The average values of the linear dimensions of the lobes of the right lung by weeks of the prenatal period of development (M ± m, mm).

Age (weeks)	Upper lobe			Mid lobe			Lower lobe		
	A	B	C	A	B	C	A	B	C
13–16	9,00 ± 0,28	5,88 ± 0,45	10,75 ± 0,33	7,60 ± 0,22	4,44 ± 0,48	11,44 ± 0,86	15,27 ± 0,22	8,00 ± 0,38	7,67 ± 0,15
17–20	17,33 ± 0,16	10,01 ± 0,21	21,37 ± 0,16	11,56 ± 0,45	7,69 ± 0,61	20,27 ± 0,85	21,67 ± 0,29	13,17 ± 0,42	13,57 ± 0,19
21–24	17,35 ± 0,12	10,50 ± 0,36	22,11 ± 0,29	12,33 ± 0,37	7,98 ± 0,37	20,78 ± 0,87	21,98 ± 0,34	13,37 ± 0,45	13,78 ± 0,23
25–28	19,00 ± 0,24	14,05 ± 0,23	27,29 ± 0,14	15,91 ± 0,64	10,05 ± 0,78	24,61 ± 0,45	31,06 ± 0,42	16,23 ± 0,48	15,84 ± 0,29
29–32	28,80 ± 0,11	14,45 ± 0,21	28,97 ± 0,48	16,97 ± 0,99	10,17 ± 0,53	27,80 ± 0,43	32,66 ± 0,48	20,37 ± 0,51	16,87 ± 0,31

Note: A - the length of the lobes, B - the width of the lobes, C - the thickness the lobes, when comparing data of each term with the previous one. Differences are significant when $P < 0.05$.

Table 4. The value of the Wurfs of the right and left lungs in the prenatal period of ontogenesis, rel. units.

Age (weeks)	Wurf values		Wurf's deviation from 1.31	
	Right	Left	Right	Left
13–16	1,31	1,27	0	3,05
17–20	1,31	1,29	0	1,52
21–24	1,31	1,29	0	1,52
25–28	1,33	1,27	1,52	3,05
29–32	1,32	1,27	0,76	3,05
33–36	1,26	1,23	3,81	2,29

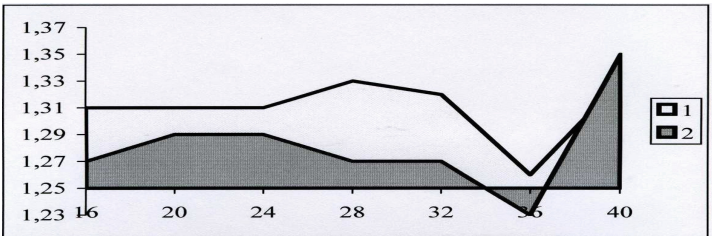

Fig. 1. Wurf curves of fetuses' right and left lungs. Abscissa - the age of the fetus, weeks; ordinate - the Wurf value, rel. units. 1 - the right lung; 2 - the left lung.

4 Findings

The principle of conformal symmetry is applied in the shaping of the lungs.

The dynamics of the linear dimensions of the human fetuses' lungs correspond to the parabolic type of growth.

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Occupational Health and Safety Management Model for Mining Contracts

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Abstract. The importance of an occupational health and safety management system (OHSMS) in a mining contract allows the establishment of guidelines to prevent and mitigate accidents that may occur in mines and in exploration areas. Such guidelines are integrated to ensure compliance with regulations with respect to the mining activity (DS 024-2016-EM). For developing a model, the literature was initially reviewed (scientific articles and research studies were used as the background), development techniques were established, and an OHSMS was proposed, with prior evaluation from the contractor. Subsequently, this study presents the general requirements, planning, implementation, verification, and the corresponding review by the appropriate authority. Finally, the model is established, supported by tables that will report the current state of the company and the implementation process. This study concludes with the execution of OHSMS in case of mining contracts.

Keywords: Occupational health · Mining · Peru · Contracts

1 Introduction

In Peru, mining is a very important economic activity because it is a sector that considerably contributes to the gross domestic product and generates considerable foreign exchange and tax revenue as well as a large number of jobs, including both direct and indirect employment opportunities. This industry pays millions in taxes along with the well-known mining royalties paid to the regional and local governments because it is a large-scale activity. Therefore, this industry should ensure the safety of its processes, develop them in an efficient manner, and care for its resources to reduce costs.

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However, incidents and accidents are extremely difficult to prevent in mining. Despite diverse efforts, fatal accidents are reported every single year. Any company that reports a fatal accident must disburse a large amount of money to mitigate damages and to conduct investigations. Therefore, an occupational health and safety management system (OHSMS) and its accurate implementation may help to reduce incidents and prevent additional disbursements of money. Because human resources are the most important resources in a mining company, OHSMS will secure their welfare for every minute that they work [1–3].

2 Literature Review

To prevent accidents, Peterson (1971) stressed the need to improve the inspection and training procedures, the assignment of responsibilities, and pre-task planning by supervisors. Abdelhamid and Everett (2000) argued that accidents usually occur because of the following three basic causes: (1) failure to identify an existing unsafe condition before or after an activity is initiated; (2) deciding to continue performing an activity after the worker has identified an existing unsafe condition; and (3) deciding to act unsafely, regardless of the initial work environment conditions. Workers stated that if more supervisors would have focused on such issues, they would be able to work safely. Additionally, majority of the workers declared that productivity bonuses forced them to increase the production rates at the expense of their safety. Therefore, young workers are more prone to accidents than older workers. This result suggests that with passing time, workers gain more experience and, therefore, get acquainted with the safety requirements. In some cases, the perceived risks were reported as low and underestimated. In this study, the workers knew very well that they could get injured, become disabled, or face the possibility of death. Hence, adequate training should be guaranteed in risky job categories so that the identified factors may be useful for the main contractors to improve their safety performance [2–4].

The research included a systematic review of the literature based on the Preferred Report Articles for Systematic Reviews and Meta-Analyses (PRISMA) protocol (Moher et al. 2009). To identify the existing OHSMS models as well as aspects related to their implementation, evaluation, and development constraints, the following five research questions were posed [5, 6]:

- Which is the currently existing OHSMS?
- What are the OHS management indicators that are used?
- What results are expected from the implementation of an OHSMS?
- What barriers exist with respect to the implementation of an OHSMS?
- How is the epidemiological management of data and indicators performed in an OHSMS?

3 Contribution

(See Fig. 1).

Fig. 1. PCDA cycle of OHSMS

3.1 Planning

An Assessment of the Risks of Each Activity is Conducted Using the Following

- Hazards identification, risk assessment, and control (HIRAC) Document.
  This is a systematic process used to identify hazards, assess risks and their impacts, and implement appropriate controls and reduce risks to the levels established according to the current legal regulations.
- Written safe work procedure (SWP).
  They are sequential steps that are described in the document to perform the activity without any complications. This procedure is for two or more people. The document must also include work instructions, which contain the same functions as a written SWP, but is addressed for just one person.
- Safe work analysis (SWA).
  SWA is performed when there is no established procedure management or the procedure is unsafe. It is also used when moving from one hazardous procedure to another one.

A List of Legal Requirements is Developed

The contractor as well as the mining company must comply with all the provisions from national regulations such as the applicable OHS regulation (DS 024-2016 EM).

The OHS regulation DS 024-2016-EM includes:

- The OHSMS policy
- The annual OHS program
- Internal OHS regulations
- OHS committee
- Training courses

Training Courses

Workers must be constantly trained not only to achieve the best performance in activities related to their roles but also in case of safety issues.

The OHS mining regulations require conducting an annual training program for workers at each level to train qualified personnel.

In mining, there are different types of training, which depend on the contractual situation of the workers.

- When the worker enters a mining company or unit for the first time.
- When the worker is assigned a new job in the same company.
- When new methods, processes, materials, machines, and equipment are introduced based on standards, SWP, and PTW (President of the Congress of the Republic of Peru, 2016).
- When they have to perform high-risk jobs.
- When a worker returns to the work site after a work accident.
- 5-min toolbox talks before work starts.
- For all the workers (including administrative staff, senior management, and supervisors), annual trainings are conducted on the following topics: rockfall prevention, use of geomechanical boards, unleashing and supporting component works, explosives, gas risks from ANFO use, blocking of energies, working in confined spaces, hot work, use of hazardous substances and/or materials, solid waste management, use of the information on the MSDS sheet, work ventilation, fixed and mobile mechanical equipment, lifting systems, stairs and scaffolding, and manual/power tools.

Communication, Participation, and Reports

All the company staff members shall be informed on the program and everything it covers, such as the objectives and proposals for improvement, to ensure teamwork and efficiency.

Documentation Control

Documentation control means that all the documents must be reviewed and approved by the relevant authority according to the type of activity conducted as part of the mining contract (PERTS, HIRAC, PTW, Standards, SWA, PTOs, Programs).

These documents must be distributed to all the workers and posted at a visible location according to the nature of each document and whether it is required by the national regulations.

- OHS regulations for mining.
- Internal OHS regulations.
- Annual OHS program.

OHS Committee
Because a mining contractor employs more than 20 workers, a joint and bipartite committee must be established. This means that the committee must have equal participation from the employers and employees.
This committee must include the following:

- The General Manager of the mining unit.
- OHS Manager.
- Occupational health Doctor.
- Other members: members and deputies appointed by the mining company.
- Representatives of the workers.

3.2 Check

Performance monitoring and measurement are conducted using tools, such as inspection reports, feedback, audits, inspections, by applying 5 safety points.

Performance Monitoring and Measurement

- **Inspections**
  Internal inspections are conducted daily and at the beginning of each work shift. However, an exhaustive inspection period must be established, where, apart from the work environment assessments, safety improvement will be measured.
- **Planned Task Observations (PTOs)**
  PTOs of the workers and their performance, production, and efficiency levels for specific tasks.
- **Audits**
  Audits assess the continuous improvement of the management system and its appropriate performance.
- **Inspections**
  Compliance with the regulations governing the activity is verified. For mining, the document used is DS-024-2016-EM (RSSO).
  It is used to inspect how the activities proposed and required by the corresponding standards are performed. For example, they may refer to training, programs, internal regulations, and the fulfillment of the functions of the members of the OHS committee.
- **Application of Five Safety Points**

  1. Check the Site Entrance and Access Road (Access inspection)
  2. Inspection of the Work Environment
     Work Environment: gases, dusts, loose rocks.
     Types of Energy: equipment and machinery.
     Tools.
     Materials/Devices.
  3. Document Review (SWP, Standards, Checklist, Training, MSDS, PTW, SWA, etc.)
  4. Safety Acts (Preventive and corrective measures)
  5. Evaluation/Review of the Previous Issues

- **Preventive and Corrective Measure Procedure (Cycle)**

  1. Identify the most frequent risks and hazards.
  2. Develop an action plan.
  3. Train workers with respect to the action plan.
  4. Implement the action plan for work tasks.
  5. Record plan or worker areas of improvement.
  6. Improve the plan and implement it again.

- **Measure Safe Performance**
  The assessment is conducted through the following activities: Incident Reports: After the corresponding investigation, a database is created, and the current rates (frequency, accident rate, and severity) are compared against the rates from previous years.

3.3 Authority Reviews

This refers to all the OHS information collected after the implementation of OHSMS.

The review in this case is performed by the management, the main participants in the decision-making process of the mining contractor of the mining unit, or the OHS committee.

This information includes the following:

- Documentation: HIRAC, PTW, SWP, SWA, PTOs, Standards, etc.
- Plans: Operational, tactical, and strategic plans
- Regulations: OHS regulations for mining activities and internal regulations
- Programs: Annual OHS and training programs
- Reports: Reports issued by workers, supervisors, heads of areas, etc.

After the review, a management report will be issued. This report will also be shared with the OHS committee.

4 Conclusions

The design has been obtained based on the proposal for an OHSMS in accordance with the methodology from the OHSAS 18001 International Standards in the Rockdrill Mining Contract. This contract was implemented in the Andaychagua Unit. In addition, the mining contract also complied with all the national regulations required by the Peruvian government for each economic activity.

It can be concluded based on various reports, such as the reports of incidents, inspections, and audits, that the number of incidents has been reduced and that the reports generated by the model provided crucial information for modifying the existing processes and procedures to ensure their continuous improvement.

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Human-Technology and Future of Work

Reduction of Cognitive Load in Complex Assembly Systems

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Abstract. Product variety and short product life cycles are characteristic features of modern assembly systems. When variety gets very high, assembly processes usually become very complex, leading to time losses, human errors, and other negative impacts of system performance. In order to prevent such performance declines different informational assistance systems become part of manual assembly systems, offering additional instructions concerning handling and insertion. Otherwise, such systems can result in additional cognitive load rather than decreasing it. Using mobile physiological measures like heart rate variability (HRV) and eye movements just in time changes of overall cognitive load are detectable. As expected, these data indicate increases of mental workload when task demands are becoming more complex. Practical and theoretical concerns, limitations and chances will be discussed.

Keywords: Assembly assistance systems · Manual assembly · Cognitive load · Physiological measurement · Heart rate variability

1 Manual Assembly Is Changing and Getting More Complex

In many sectors the industrial age with its tayloristic character is coming to an end. It is going to be replaced by the so-called information age, which is characterized by a higher complexity in production processes and more flexibility of work. This development also affects manual assembly systems. On the macro level, there is a trend towards lower production depth and more dependency on suppliers, smaller batch sizes, additional functionalities and greater variety of products. The effects on the micro level of the individual workplace can be seen in a broader range of parts, equipment and tools to use, ever changing assembly processes and in various enrichments through numerous functional controls and procedure choices [1, 2]. This results in a loss of predictability and routine for the assembly worker. Thus, complexity implies a need to cope with more and more uncertainty regarding the upcoming assembly requirements on the one hand, and on the other hand to act with more attention to answer the demands of faster changing work processes.

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As a consequence, this paradigmatic change from a stable assembly process based on simplicity, predictability, and repetition towards a faster changing and more complex assembly process requires a digitalized information management system up to the integration of the individual assembly worker. For a flawless assembly process it is indispensable that the worker gets the right amount of information at the right time. Thus, for reasons of productivity there is a need of digital collaboration of all involved departments like construction, industrial engineering and logistics to get repeatedly updated information (changed parts, tools, processes) about the current assembly product. At the same time, for reasons of humanity the single worker needs supportive information in order to overcome his uncertainty.

From an ergonomic point of view, the informational component of work becomes more prominent. Therefore mental processes like recognizing, deciding and choosing between alternatives, which until now have largely remained unnoticed, are gaining attention. Ergonomics is shifting from a more physical-energetic approach to a more mental-informative one. So far, ergonomics focused mainly on the interplay between physical stress and physical strain, but now the interaction of informational stress and mental demands and thus information processing and action regulation get increased consideration [3]. Physical load and physical load measurement are replaced by cognitive load and cognitive load measurement [4].

2 Assembly Complexity and Cognitive Load

A mixed-model assembly system is considered to be complex. Depending on the given initial condition, the worker has to make a choice between several possible process steps in order to achieve the mission objective. This includes a sequence of cognitive processes. This means to perceive and pick up the given initial condition, to recognize the specific requirements (build pump type A), to decide on one of several possible action patterns and then to translate the abstract pattern into concrete action.

Thus, complexity could be conceptualized as a kind of uncertainty, which is the result of the number of decisions the operator has to make on the way to finish his task, e.g. concerning the selection of parts, tools, and assembly procedure. Based on this idea, Zhu et al. [1] define assembly process complexity as operator choice complexity, which describes the “entropy computed from the variant mix ratio” (p. 46) relevant in a specific activity in a specific station. Thus, high assembly complexity contributes to high choice complexity of the operator, asking for a high amount of attention and concentration. Both are to be seen as central elements of cognitive load, workload or mental strain. Complexity therefore is not based alone on a high variety of products, but also on a high level of information to process in order to regulate one’s own behavior. The amount of information to process or the extent in which cognitive resources are needed to process them is varying with experience and familiarity of the worker with the workstation, the work process, and the object to be assembled. New, unexpected and surprising information will force a shift of attention, a disruption of flow and routine behavior, and a delay in the normal working process.

As in the case of physical stress, it is hypothesized that an increase of complexity of task demand leads to a decline of performance, e.g. time loss or human errors. In order

to prevent such performance declines there is a tendency to ameliorate information management in order to reduce uncertainty and mental stress and to compensate lacking knowledge and behavior control. Informational assistance systems of different kinds (e.g. tablets, AR-glasses or projection systems) function as supportive devices during information processing, e.g. to make correct choices, to assemble properly or to be attentive. As part of the assembly system, such assistive systems generally offer additional instructions concerning handling, fixation and insertion, thus leading to reductions of operator choice complexity [5].

3 Measurement of Cognitive Load

Measuring environmental factors at the work place which cause a change in physical or cognitive load is a more or less difficult task. The weight of an object, the loudness of the surrounding or the temperature at work are more or less time-constant, physical quantities rather easy to measure. Measuring how and when information gets processed by an employee and what kind of demand this causes is a more difficult endeavor, because there is a lot of natural fluctuation. This is the reason why in the past the main focus of ergonomics was on physical factors [6]. Physical load is more centered around outer structures, however, cognitive load is constructed as an internal phenomenon relying on internal structures and processes.

With the development of smaller, lighter and mobile equipment to measure physiological responses in real time at work, objective measurement of cognitive processes and cognitive load became more prominent in ergonomic research. Cognitive load is conceptualized as the amount of information imposed on the working memory during performing a specific task. Thus, external information gets in contact to a limited capacity of internal resources. The concept of mental stress implies that cognitive load and cognitive resources are not in balance, which means the extent of demands placed by the task is higher than the amount of resources at ones disposal.

The mismatch between needed and available mental resources leads to a measurable physiological response. This response is mostly triggered through the reaction of the autonomous nervous system (ANS). As a result of an informational overload and a lack of cognitive resources, an ergotropic, sympathetically innervated reaction may lead to an increase of heart rate (HR), decrease of heart rate variability (HRV) or a change in the activity of the brain, for example measurable via a change in the amplitude of the P3b activity [7]. There is a broad range of possible methods to measure cognitive load using for example activity of the heart (ECG), muscles (EMG – for example facial muscles), skin response (GSR), eye and gaze properties and eye movement (Eye Tracking) or brain activity using EEG or fNIRS. Using a single indicator to measure cognitive load seems to be inappropriate [8]. A multimodal approach can reduce ambiguities and help to create a more valid indicator to measure cognitive load. Performance indices gathered through observation can not only be a further indicator for cognitive load, but also help to detect potentials of informational assembly assistance systems [4].

So far the measurement of cognitive load relied on more subjective measurements. These often lack in validity and in the possibility to measure them during the working

process in real-time. Modern mobile measurement tools enable non-invasive techniques to measure cognitive load not only in laboratory settings, but also in field studies.

4 Method and First Results

Using a 3 × 3 factorial design the interaction between assembly complexity and used informational assembly assistance system was tested. As assistance systems a classical paper based approach was tested against voice controlled tablet and augmented reality glasses based solutions. Beside assembly time, errors and subjective impressions, continuously monitored physiological parameters were used to assess cognitive load during the assembly process, consisting of six different realistic pneumatic models to be assembled. These models were classified as either simple, moderate or complex (two of each) and had to be assembled in a strict order. The assembly assistance systems provided all necessary information to assemble the product, divided in more decisional aspects (choosing and picking the right parts) and instructional aspects of how to handle chosen parts. All assembly processes were video recorded by the eye tracking device.

To measure cognitive load during the tasks participants were equipped with an ECG for gathering heart rate (HR) and heart rate variability (HRV), as well as a mobile eye tracker to get in pupillary response, fixation times and feature selection. For the analysis of HRV, the specific parameter rrHRV was chosen [9]. Finally, subjects had to fill in the raw NASA-TLX questionnaire after each difficulty (model 2, 4 and 6). Results indicate that with increasing complexity of the models subjects experienced more mental strain.

Manual assembly is a complex, quickly changing process with alternating parts of cognitive and physical activity. Cognitive-informational and physical-energetically activities often are not separable. As Fig. 1 shows, with increasing complexity assembly time increases too. However, cognitive load does not indicate such a simple linear association. As can be seen, there is a constant up and down of all physiological parameters – representing normal and work specific fluctuations of cognitive load. For HR high values normally correspond to phases with more physical activity like going around, picking the parts or inserting parts with tools. Mean HR is not changing drastically between the models.

HRV seems to be a more valid indicator for cognitive load. Higher values of HRV (indicating low cognitive load) occur predominantly during the final phase of most assemblies, when subjects are working and handling physically. Lower values of HRV (indication higher cognitive load) are more often to be found during the starting phase of assembly, when new information has to be processed.

Pupillary responses show an even higher temporal resolution for cognitive load compared to HRV. One of the most instructive results of the pupil diameter analysis is the decline during the last model to be assembled. A deeper analysis of the video files shows, that this decline is related to handling activities, which are identical to those, which have been learned in earlier models. This confirms the idea, that learning and experience reduce cognitive load.

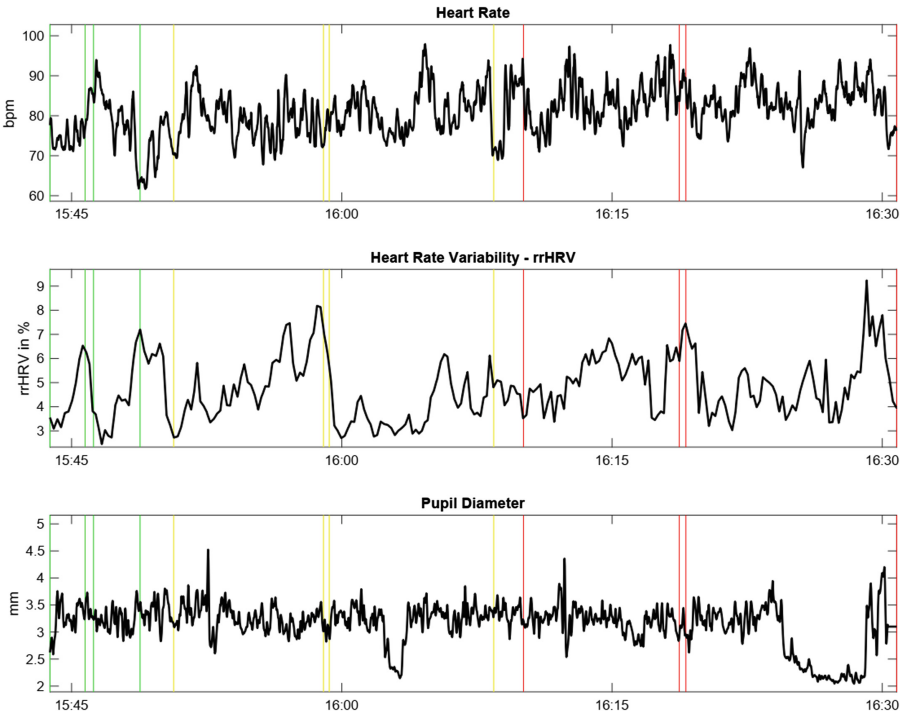

Fig. 1. Heart rate, HRV (rrHRV) and pupil diameter of a typical subject during working tasks with increasing complexity (green = simple tasks, yellow = moderate tasks, red = complex tasks)

5 Combining Cognitive Ergonomics and Physiological Measurement Is a Difficult Task

To determine task demands and to measure physical and cognitive load separately during manual assembly processes is a difficult task, as both kinds of load are the result of rather simultaneously appearing and continuously changing working processes. Thus, single choice processes and handling processes are rather difficult to separate. One cause is, that both are related to ANS-activities and effort, another one, that physical activities produce masking and confounding effects. A final cause concerns different latencies of physiological indicators. The heart reacts much slower to changes of the ANS than for example pupil dilation. Therefore, data alignment of different physiological parameters needs to be done in advance to compare those indicators validly and combine them to one cognitive load parameter.

To reach the full potential of cognitive load measurements it is necessary to expand analysis beyond post-hoc and mean comparisons. Just-in-time analysis of ECG, EEG, eye tracking or comparable measurements might be good approaches but still need some fine-tuning. Subjective baselines need to be determined, redlines for workload to

be defined [10] and change points be detected in a valid way to separate short peaks from longer plateaus [11].

There are still good reasons and chances to use even single indicator solutions to measure for example cognitive load to analyze the usage and usability of cognitive assistance systems. However, for the future there might be the chance to use machine-learning algorithms to manage and control such assistance systems or assembly processes relying on individual physiological data [12].

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Synthetic Consequential Reasoning: Facilitating the Design of Synthetic Morality in Highly Automated Systems via a Multidimensional-scalar Framework

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Abstract. This paper reviews the four fundamental frameworks available in normative ethics to underpin the most suitable strategy to facilitate the design of synthetic morality in the context of Highly Automated Systems (HAS). Based on research findings, it will present an updated multidimensional-scalar system of levels of automation specifically adapted to Highly Automated Systems (HAS) in the context of Human-Human-Interaction (HHI). This framework integrates the variables of autonomy, accountability, reparation, actions, contexts, access and inferences to build and facilitate the design of synthetic morality on highly automated unsupervised systems form a consequential perspective. As part of this process, a form of calculation emerges to facilitate the calibration of moral computational reasoning in the context of HAS.

Keywords: Human factors · Human-systems integration · Systems design · Synthetic morality · Consequential reasoning · Highly Automated Systems · Complex dynamic systems

1 Introduction

Due to the ever-evolving complexity of highly automated systems (HAS), "no amount of testing can formally guarantee that a system will behave as we want" [1]. With this statement, DeepMind, the most advanced AI company in the world, summaries the current state of the art in the field of Artificial Intelligence. In large-scale models enumerating all possible outputs for a given set of inputs, remains intractable due to the incredible number of choices for the input perturbation. In this context, users and the general public are becoming increasingly concerned with issues of unexpected outcomes leading to a lack of trust in these systems. This problematic demands the design of systems and tools that can integrate moral reasoning as part of their reasoning capabilities.

In order to resolve this conundrum, this paper will critically analyse the four most relevant frameworks in normative ethics to underpin the most reliable approach to design moral computational reasoning; Socrates's virtue, Jeremy Bentham's Consequentialism, Emmanuel Kant's Deontology and John Dewey's Pragmatism.

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They incorporate the three main existing frameworks in normative ethics plus Dewey's Pragmatism. The latest allows the authors to address ethics at a systemic level.

- Virtue refers to being. In this paradigm, morality emerges from the identity of the individual rather than their actions or consequences. Practical reason results in action or decisions chosen by a suitably 'virtuous' agent.
- Consequentialism states that the consequences of somebody actions are the ultimate basis for any kind of judgment regarding that action. This perspective focuses on the outcome of conduct.
- In deontology, actions are conditioned by a set of rules, may they be natural, religious or social. This perspective focuses on the intentionality of conduct.
- In Pragmatism, actions and consequences are possible because the context or system allows for them. This paradigm aims for social reform as a strategy to address morality. In this perspective social reform is prioritised over intentionality, consequences, individual virtue or duty.

The fundamental problem with Dewey's perspective is that in order to change the system we need to generate global consensus. In this context, some initiatives such as GDPR have been taking place, but they felt short [2] and rapidly become redundant. The GDPR was introduced on 25 May 2018 and on 24 October 2019, the German government was introducing a new framework [3]. The limitations of access and rapid technological exponential development prevent Dewey's framework from addressing the design of a system.

In Socrates's virtue, the fundamental problem is the limited capability of humans to assess what is happening. The acceleration and volume of information delivered by social interactions and algorithmic updates is fragmenting reflection and cognition by disconnecting the pre-frontal cortex by saturation. Our attention span has been reduced from 12" to 8" in four years by multitasking [4]. After 21 min comparing information our pre-frontal cortex shuts down [5] and only information with a big emotional impact is retained. These processes are transforming society from reflexive to reactive and it is questioning the idea of truth and reality by repositioning the decision centre from reason to emotional experience. Thus invalidating the model proposed by Socrates based on reason.

In Emmanuel Kant's deontology the ethical intervention is placed on the intentionality of the system. Its fundamental problems are interpretability and interruptibility. The system does not know what is doing, therefore, it cannot stop. According to researchers from the most advanced AI company in the world DeepMind, this is currently impossible [6]. Insofar as we are not capable of designing them, it is not a suitable strategy. Consequently, the only paradigm remaining is Consequentialism. In this framework the fundamental elements are the consequences of an action, therefore, the system will be judged by the consequences of its actions.

1.1 Synthetic Consequential Reasoning

Building from this ethical perspective, the lead author developed a multi-dimensional scale system to build consequential reasoning in computational systems [7]. The enquiry started by building a foundational scale of levels of autonomy. This technique

has been widely used in the human factors field over the last 40 years. However, as a consequence of the impossibility of monitoring complex dynamic systems due to their complexity, two fundamental questions emerge; if something goes wrong who is responsible? and is it possible to repair the trust of the user in the system? These question led to the articulation of two complementary consequential scales. In this context, two workshops were conducted to map highly sensitive areas and from the knowledge generated eight case studies (two cases with high and low intensities for each sensitive area) were built to understand whether this multi-dimensional system would be able to address them. The results were positive, however context and actions emerged as fundamental variables to incorporate in the framework, as they determined the right combinations of levels. Then, building from the work of Sandra Wachter in the area of law and algorithms, we integrated two more variables; access (data points) and inferences (predicting capabilities) [2]. Finally, we designed a system integrating all these variables and developed a risk analysis tool with a form of calculation to obtain a trust rating to calibrate the system [7]. (Fig. 1) (see [7] for an extended explanation).

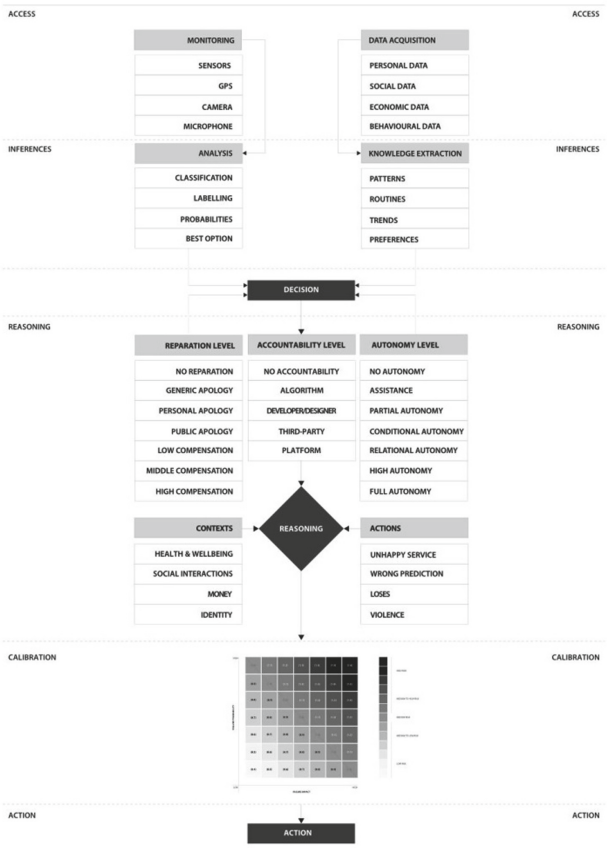


Fig. 1. Synthetic consequential reasoning framework

2 Method

In order to test the proposed framework, a workshop with students from the Master in Research program at the Royal College of Art was implemented. They represented a mix of backgrounds in fashion, textile, architecture, computer science, industrial design, and engineering. The lead author defined the main area of intervention; health and wellbeing. This area was specifically selected due to its moral nature and impact. Then, a design task around a highly automated Virtual Assistant capable of diagnosing and providing treatment in the area of depression was structured.

As part of the workshop, the main author introduced a demo called Duplex to illustrated the nature of the system, and a small analysis underlined the key characteristics of upcoming Virtual Assistants. Students had 50 min to complete this task. We provided the aforementioned framework in the form of a calculator with all the variables. This tool provided a trust rating to calibrate interactions beforehand.

In order to understand the validity of the framework a comparative analysis was implemented to understand whether new elements not considered in the proposed framework emerged. Once the task was completed, the authors designed a semi-structured questionnaire to understand four elements; usefulness of the use of the calculator, whether the calculator helped them to improve their design, specific usefulness of the rating and whether the rating helped them to fine tune their decisions. The questionnaire consisted of two areas; a quantitative section asked participants to rate these elements by using an eleven point Likert scale and a qualitative section asking participants to expand why and how these elements have affected their design.

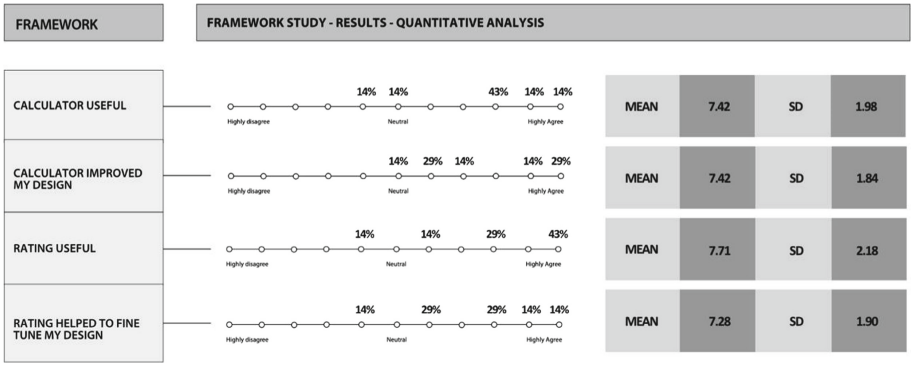
3 Discussion

In terms of differences (new elements not considered in the proposed framework). No alternative emerged to the proposed scales; autonomy, reparation and accountability. Neither differences emerged in terms of contexts and actions. However, subtle differences emerged in terms of access and inferences. Biometric data and the body present a categorical novelty to account in terms of data points, and language and rhythms emerged as new elements not previously considered in terms of inferences.

ACCESS		INFERENCES	
MONITORING	DATA ACQUISITION	ANALYSIS	KNOWLEDGE EXTRACTION
SENSORS	PERSONAL DATA	CLASSIFICATION	PATTERNS
GPS	SOCIAL DATA	LABELLING	ROUTINES
CAMERA	ECONOMIC DATA	PROBABILITIES	TRENDS
MICROPHONE	BEHAVIOURAL DATA	BEST OPTION	PREFERENCES
BODY	BIOMETRIC DATA	RHYTHM	LANGUAGE

In terms of the usefulness of the framework in the form of a calculator participants rated it with a 7.42 mean value. In terms of product improvement, participants also rated the usefulness of the tool with 7.42 mean value. In terms of the rating usefulness, participant rated this element with 7.71 mean value. In terms of the effect of the rating to fine-tune decisions, participants rated it in with 7.28 mean value (Table 1).

Table 1. Quantitative analysis



In qualitative terms, participants described how these elements affected their decisions by understanding the impact on trust of the interaction beforehand. This exercise led to participants reducing risks by giving them a better perception of the implications their design may have on the user's trust. By the results presented we can establish that the framework and its mode of calculation is useful to facilitate the design of moral computational systems.

4 Conclusion

This paper presents an innovative multi-dimensional scalar system integrating post-interaction elements such as accountability and reparation, and integrating unintended actions, contexts, access and inferences as fundamental variables to facilitate the design of synthetic morality from a consequential perspective on unsupervised highly automated computational systems in the context of Human-Human-Interaction (HHI). This perspective has been traditionally missing in the design of computational systems and tools which fundamentally revolve around a priori strategies focusing on intentionality and monitoring. As part of this process, a form of calculation emerges to facilitate the calibration of moral computational reasoning in the context of HAS.

Finally, the study has underpinned four new elements. In terms of access, biometric data and the body, and in terms of inferences, language use and rhythm emerged as new sub-variables to account. These elements have been added to the previously proposed framework. Future work will be dedicated to build a functional prototype.

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Green Capitalism: Democratizing Sustainable Innovation by Recycling Intellectual Capital Energy

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Abstract. Climate change and global warming are posing a threat to the planet's biodiversity placing the world's population at risk. For many years, NGOs, Governmental bodies and entrepreneurs have tried to tackle social and global environmental challenges by the roots through direct action. Nonetheless, those initiatives often fail to achieve short-term, mid-term and long-term impacts, turning out as ineffective solutions to the urgent environmental challenges. The problem lies in the nature of those initiatives as their main objective are solutions for the world's problems, denying and rather taunting any profitability aspirations. This paper introduces the concept of Green Capitalism which describes how firms can increase profitability by inventing sustainable products/services. It introduces a new way of thinking, based on the Democratic New Product Development (DeNPD) Model in an effort to reduce non-marketable idea wastage and transform it into profitable sustainable innovation with the contribution and participation of the society and individuals.

Keywords: New Product Development · Green Ocean · Company Democracy · Holacracy · Sustainability · Environment · Innovation · Knowledge · Management · People · Intellectual capital

1 Introduction

Unlike the NGOs, capitalistic organizations, are bottom-line driven and often contrarily detached from the bigger picture such as environmental issues, poverty, justice, peace, etc. However, due to the continuous efforts of activists, the last decades have brought a massive rise in environmental consciousness amongst consumers. Therefore, in order

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to stay competitive in the future, firms must acknowledge the sustainable expectations of their customers and incorporate sustainability in their practices. In traditional organizations, sustainable product knowledge derives primarily from the R&D departments. This kind of human capital usage limitation restricts the efforts to design sustainable products and services. By moving into a Holacratic R&D approach, other experts in the organization can also contribute to the R&D efforts with knowledge and skills per case. This can be extended into a democratic R&D approach, with the knowledge contribution of every employee on specific R&D projects activities. However, and when it comes to sustainable innovation the society which is often neglected, can play a significant role in what is sustainably relevant. This transformation can be achieved through the Democratic Green Product Development Model (DeGPD).

This paper introduces the concept of Green Capitalism which describes how firms can increase profitability by inventing sustainable products. It also introduces a new way of thinking, based on the Democratic New Product Development (DeNPD) in an effort to reduce idea wastage as non-marketable, and transform it into profitable sustainable innovation with the contribution and participation of the society. Organizations of any size and in any industry can achieve this transformation by using the DeGPD as a tool towards reaching Green Oceans.

The model recognizes and utilizes the contribution of the society as an industry partner with better understanding and empathy for environmental issues, able to make better judgments about the relevance of a product compared to investors or other capital-driven decision-makers. The model operates on six levels in a tryptic pyramid structure, representing the relationship of a product's success, with the contribution of the society in sustainable product development, the product's sustainable value acceptance, and the organization's contribution index to sustainable development. The DeGPD, within the concept of reducing knowledge wastage through the contribution of the society, can turn traditional blue ocean-oriented capitalism into green ocean-oriented, or simply into Green Capitalism, offering value to the economy, the society and the environment, by saving the planet profitably.

2 Challenges and Risks of the Green Economy

With the steady and alarming rise of the global ecological footprint, organizations and governments attempt to collaborate on framing sustainable global solutions. Despite achievements such as consensual targets agreed upon in several summits, forces of change do not solely rely on international actions. Indeed, consumers, companies and local institutions are gaining awareness around the possibility of engaging in and building a green economy. The term 'sustainability' became increasingly popular, a business opportunity for some companies, and a marketing buzzword for others. Transitioning from short-term business actions to long-term sustainable investments is crucial. The need for transformational change means changing the old and embracing the new, by being bold and innovative with committed to taking actions [1]. However such transformation faces significant challenges in strategy and actions.

Historically, managers have regarded environmental initiatives as utterly opposing to profit aspirations [2]. Producing sustainable products/services is indeed costly from many dimensions starting from the supply chain, to the raw materials, the manufactured sustainably, the reduction or zero usage of harmful chemicals, labor costs, acquisition of third-party certification labeling sustainable products, compliance with regulations and standards environment, healthy etc. [3]. As a result, many companies attempt to avoid sustainability measures, fearing it could affect their business operations strategy, production speed and volume, product/service pricing, productivity, profitability, performance and competitiveness. Therefore companies that commit to environmental impacts, need to place their products in the market for a high price to sustain the profit margins to be financially sustainable and viable.

Expensive products, however (i.e. fair trade consumer discretionary products), make consumers, especially those facing financial constraints without motives and means to return to the environment, reluctant towards sustainable products which seem more of a luxury than an ethical act, and a lifestyle for the privileged ones who can afford them. The environmentally friendly market has been narrowed to the ones privileged to afford green products, limiting the ability to reduce prices, increase demand, increase the markets, impact more people and indeed return to the environments with the help of many and not the few. Therefore there are real challenges in the Green Economy to be solved, starting by making green products affordable.

3 The Role of Society in Sustainable Innovation

Despite the fact that environmental awareness concerned the world after the second world war, it is only the last decade that the society and the governments have been significantly active to contribute to this global threat and concern. In the 1960s, the concern about environmental sustainability was raised as a response to critical traffic congestions, which was the result of the increasing car ownership in the 1950s [4]. The public started to engage in protests to raise awareness and make it a government concern. Political actions regarding environmentalism are primarily based on natural resources consumption but rarely placed into a societal context [5]. Green activism efforts of the late 20th century did not have enough outreach to carry the spark needed on consumerism by society.

Due to the intensification of the climate crisis in recent years, environmental efforts are being propelled by the younger generations. International movements like Fridays for Future [6] in which children abandon school duties in order to strike for the climate in 150 countries have raised awareness across the globe as a multi-generational concern, highlighting consequences of such negligence. Relayed in modern platforms, the global citizen movements gained momentum. Consequently, consumers' expectations evolved from utility and commoditization to shared-value contribution. Today people are keen to sacrifice cheap prices if in return they can satisfy their conscience and contribute towards climate change preventing. In order to respond to those customer changing demands, more companies incorporate sustainability into their processes and product portfolios. It seems that the degree of environmental sustainability of companies is essential to the financial sustainability they shall have in the future. Henceforth, the society can possibly

make a large-scale environmental impact by influencing political decision-making through large scale activism, and by influencing the new product development by changing, if not imposing, their consumption habits and expectations.

4 The Green Ocean Strategy

The concept of Green Strategies has been floating in the literature for quite some time without consensus on the term itself, the practices to design and apply such strategies and the practical tools needed to support them. In 2019, E. Markopoulos, I. S. Kirane et al. theorized the Green Ocean Strategy in an extended and upgraded version of the Blue Ocean Strategy. This strategy goes beyond the simple and theoretical cliché of 'thinking outside the box', 'think different', 'think lateral', 'flip the question', etc. The model aims to create sustainable market spaces, while perpetually maintaining the relevance of the company, providing a more holistic approach to the organizations that are floating today on Green Oceans by relating fair trade with social development. To effectively sail on Green Oceans, companies need to achieve the triptych of going Green by designing and implementing Social, Economic and Environmental strategies. Green transformation requires practical tools to be elaborated in the Green strategies that can create a bond with their customer base through added-value innovations, which must be profitable and successful enough to drive into market dominance. Green Ocean Strategy (Fig. 1) is executed with tools and practices, such as the 3S Matrix for strategy development and implementation, provided in the Turquoise canal, the transition phase from Blue to Green, offering the opportunity to organizations to achieve sustainable corporate transformation in products, services and operations.

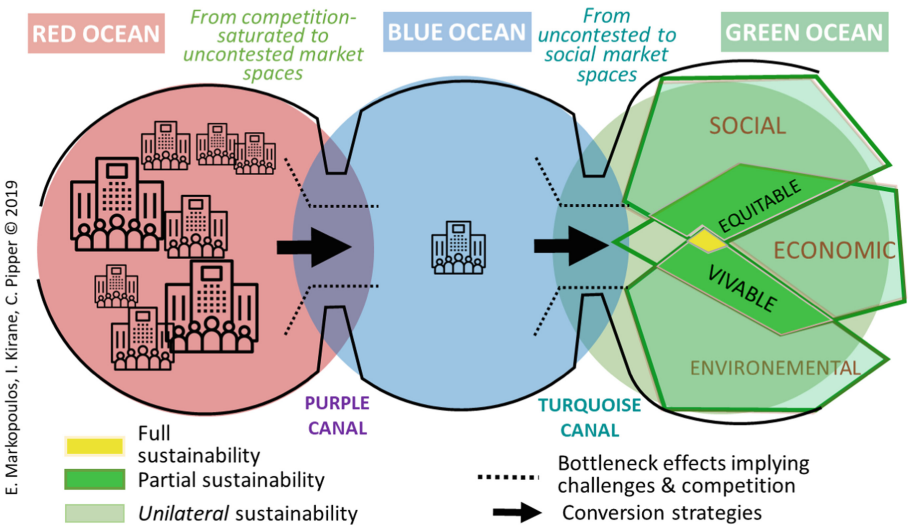

Fig. 1. The Green Ocean Strategy, a transition process for long-term profitability.

5 The Green Innovation Waste Management Protocol (GIWMP)

The practical effectiveness and success of a Green Ocean Strategy is determined by the number, value and impact new green products and services are developed, but also the utilization of the knowledge that did not become part of the Green Ocean elements that composed the strategy. Knowledge and innovation of any form is a result of energy placed in thought, actions and results in attempts to improve people's lives under any dimension. The knowledge that does not get applied, for any reason, is a waste of intellectual energy that humanity and society can not afford to lose or ignore. Intellectual energy is related to an extend to environmental energy from the resources used to develop it over small or long periods of time.

Therefore, as knowledge is a valuable intellectual capital produced with physical and mental energy, must be preserved, recycled, and certainly not wasted. To achieve such a goal, the Green Ocean Strategy addresses this challenge with the Green Innovation Waste Management Protocol (GIWMP). The protocol is executed under a conceptual framework aiming to reduce knowledge wastage by guiding companies to achieve more efficient idea generation for sustainable product development, contributing to the Green Oceans Strategy initiatives. GIWMP operates within the integration of the Democratic Green Product Development Model (DeGPD) and the Green Ocean Strategy by integrating the society in a new Green product development process. Following the Social Enterprise Design Thinking Model, GIWMP measures the number of ideas and knowledge generated over the three innovation evolution phases of Inspiration, Ideation and Implementation for new product development under a Green Ocean Strategy perspective (Fig. 2).

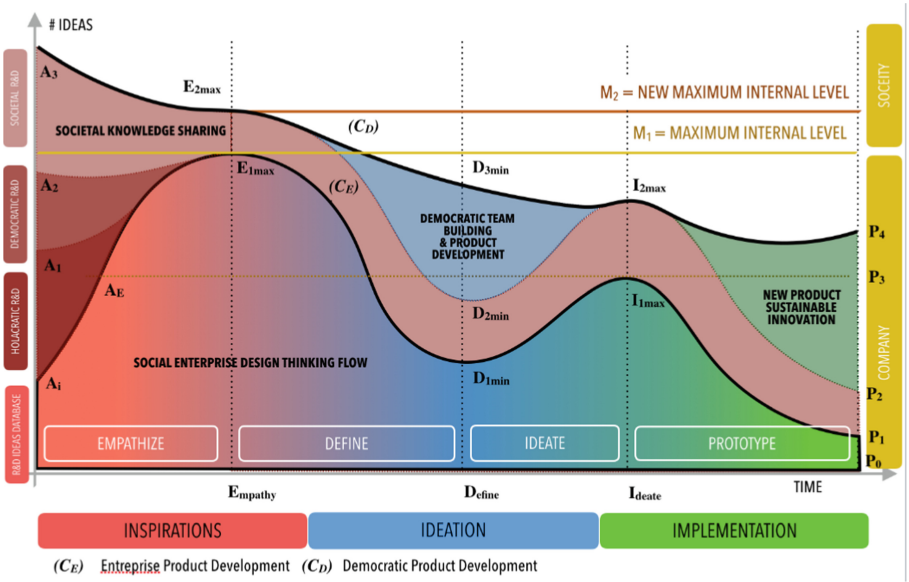

Fig. 2. The Green Innovation Waste Management Protocol (GIWMP)

5.1 GIWMP Innovation Evolution Phases

The GIWMP evolves over three phases. The first phase 'Innovation' evolution phase is the Inspiration linked with the Red Ocean Strategy [7] and defined as the known market space with defined industry boundaries in which companies try to obtain a greater share of the existing market by outperforming their rivals. In product development, this derives from the comparative analysis related to the market (stakeholders, competitors, socio-economic frame).

The second phase 'Ideation' is linked to the Blue Ocean Strategy where there is a simultaneous pursuit low-cost of differentiation to establish new demand and market spaces. It is the state where the possibilities to extend opportunities outside the current environment are considered.

The third phase 'Implementation' is linked with the Green Ocean Strategy. It is the space were products/services extend from innovation ideation to sustainable implementation. This phase enables the creation of sustainable market spaces while making the company perpetually relevant. This phase aligns the whole system of the firm's activities with its human intellectual capital for differentiation and low-cost [8].

5.2 GIWMP Product Development Timeline

The Product Development Timeline in the GIWMP protocol elaborates on the basis of the Social Enterprise Thinking Model, converging both the Design Thinking Model and the Human-Centered Design Model [9]. The GIWMP graph is being expressed on the basis of the Number of Ideas/Knowledge (y) per amount of time (x). Specifically:

Initial point (where $y = A_i$ and $x = 0$): Refers to the number of knowledge already available in the R&D department of the company, coming from previous market research, prototypes, surveys, customer feedback reports, etc. The distance $y = A_i$ can be expressed as the R&D Knowledge Database.

First ascendant curve (C_E; where $0 \leq x \leq E$): Refers to the Inspiration phase in the literal sense or popular understanding: the R&D team usually brainstorms a set number of ideas (C_E from A_i to A_E), followed by a phase where employees and engineers amplify the brainstorming stage via ideas interpretation (C_E from A_E to E_{1max}).

First maximum of the curve (C_E at point $E1_{max}$): Refers to the culminant moment of the R&D phase when a large volume of ideas is being pooled. The graph gets tangent to the maximum internal level (M_1) of the company ideas (yellow line).

The Initial Point, first ascendant curve, and the first maximum of the curve are part of the Inspiration phase and complete the Empathy phase. Empathy is necessary for adequate inspiration ideas-providers must understand their targeted audience. As a result, the R&D process will be truly answering the evolving needs and changing wants of the customers.

The first descendant curve (C_E; where $E \leq x \leq D$): Refers to the transition phase between Inspiration & Ideation. When ideas are turned into projects, there is a natural and necessary selection process where ideas with high success probability enter the Ideation stage. In this phase conditions, parameters and variables are expressed and defined. The 'Definition' phase is a transition between 'Inspiration' and the 'Ideation'.

First minimum of the curve (C_E at point D_{1min}): Refers to the end of the Definition phase, when the ideas selection ends after one or many meetings and the number of

ideas to be realizable has been reduced to a level noted D_{1min}. It is the state which generates Blue Ocean Strategy due to the mindset change achieved at this instance where the R&D team starts thinking outside the box to integrate a level of innovativeness to the retained ideas.

Second ascendant curve (C_E; where $D \leq x \leq I$): Refers to the pure Ideation phase, the moment when the R&D phase conceptualizes how to transform intangibility and tangibility. This natural increase of ideas, due to the Blue Ocean Strategy mindset, and the fact that tangible conceptualization requires innovativeness in the process of fabrication, marketing strategies, etc., might alter the output of the initial idea.

The second maximum of the curve (C_E at point I_{1max}) Refers to the end of the Ideation phase, where a significantly higher number of ideas generated, combining pure outputs and engineering processes.

Second descendent curve (C_E; when $I \leq x \leq P0$): Refers to the prototyping phase where the actual fabrication of variants of the output gets to be commercialized. In a regular product development process, portfolio ideas are significantly reduced due to the optimal selection process based on financials, assets capabilities, contacts, legal compliance, etc.

While the 'Definition' and 'Ideate' instances are part of the Ideation phase in general, the prototyping is part of the implementation phase.

5.3 GIWMP Process Democratization Plan

The Process Democratization Plan in the GIWMP refers to the aggregate of areas beneath the C_D curve and above the C_E curve. The C_D Curve refers to the desired Democratic Product Development curve, while the C_E curve refers to the Enterprise Product Development curve (or classic product development). The areas and the company's behavior results from the Holacratic R&D, the Democratic R&D and the Societal R&D.

Holacratic R&D: Holacratic management is a new growing corporate culture trend. Transforming the R&D units management under the holacratic principles of continuously rotating research participants per case and project [10] provides an additional initial level of ideas generation ($\Delta H = A_1 - A_i$) compared to the traditional R&D management methods [11].

Democratic R&D: Democratic management where knowledge contributions can derive from anyone and at any time, substantially increases ideas through the use of the Company Democracy Model ($\Delta CDM = A_2 - A_1$). CDM is a knowledge elicitation model that transforms human intellectual capital contributions from basic ideas to disruptive innovation products and services [12].

Societal R&D: Societal R&D is the ultimate level of organizational openness and maturity to engage third parties and benefit from their contributions. Societal R&D implementation allows internal as well as external thinkers, engineers, and domain-experts to provide their ideas through the DeNPD approach. The Societal Knowledge Sharing allows the Company to achieve a higher level of Ideas than their maximum internal level ($A3 > M_1$).

This three-stage knowledge democratization roadmap allows a wider spectrum of ideation, and acts as a benchmark for marketing research (identifying evolving needs,

wants, habits, etc.) and avoiding innovation myopia. Sustained growth depends on how broadly people define their business, and how carefully they gauge their customer needs [13]. Optimizing the Ideation phase with the participation of the entire organization first and the society after that though democratization, amplifies the level of commercialization realized per number of ideas (or prototypes) through the new product sustainable innovation.

6 Green Capitalism Through the DeNPD Model

The utilization of the society as a knowledge generation engine for green product ideas is based on the ethical, effective and rewarding integration of the citizens through a democratic process. An approach to achieve this challenge is the Democratic New Product Development Model (DeNPD) (Fig. 3), which provides the framework on bringing ideas from the society into a company [14].

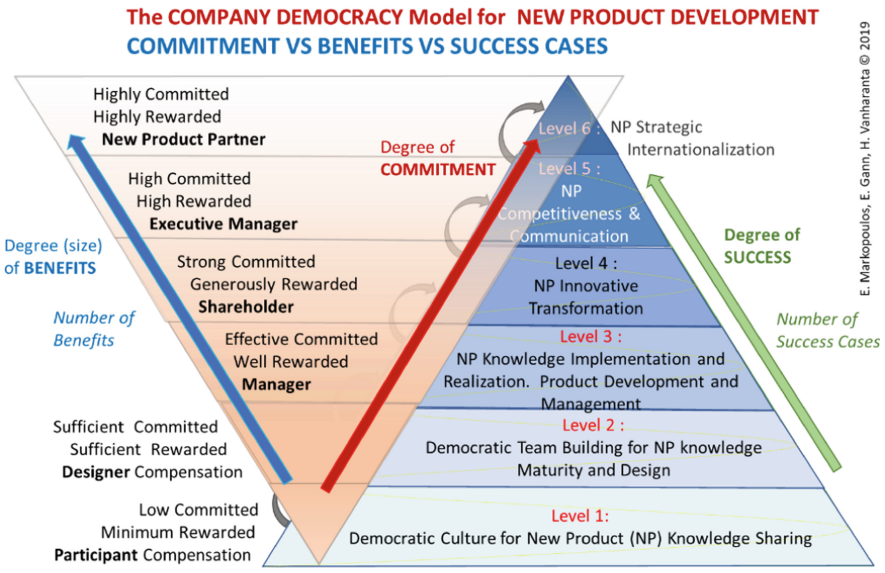

Fig. 3. The Democratic New Product Development Model (DeNPD)

The credibility and ethicality of the DeNPD Model relies on the DeNPD Company House, an intermediary independent authority, responsible for registering ideas generated by the society, as well as companies' product requests, and managing the matching between knowledge supply and demand.

The collaboration between companies and individuals extends the Company Democracy Model operations with the formation of a reversed pyramid in which the engagement and the benefits of the individuals are escalated. The DeNPD captures three essential relationships which are the success of the product, the degree of commitment of the individual, and the number of benefits/rewards an individual receives. At the early

stages of this industry-society collaboration, the individual solely shares product ideas with the organisation on limited commitment and benefits. The commitment increase of the individual in the NPD process provides more opportunities, benefits and stabilizes collaboration relationships with the organization. The DeNPD allows the society to realize its product needs, openly, with equality, distribute earning rewards, reduces corporate R&D cost, and increasing innovation in a win-win framework.

This application of the Democratic NPD model in a green context eases the path towards Green Oceans with the utilization of intellectual capital energy invested by individuals ignored by the industry. By integrating the citizens in the process of idea generation for green product development, companies can reduce idea wastage and issue a better judgment on the relevance of ideas for sustainability and profitability.

7 The DeGPD Model

Based on the Democratic New Product Development (DeNPD) and the Green Innovation Waste Management Protocol (GIWMP), the Democratic Green Product Development (DeGPD) is being developed to ignite Green Capitalism. The DeGPD extends the Blue Ocean driven DeNPD on solving the critical for the human existence global environmental challenges and risks the world faces today with the implementation of Green Ocean Strategies in Green New Product Development. However, the transition from the Red to the Green Ocean without passing through the Blue Oceans can result in financial risks, if long term sustainability cannot be secured by the organization's operations. Thus, a third pyramid is integrated into the DeNPD model to empower Green Capitalism in which the 3S innovation triptych of the Green Ocean Strategy transforms the knowledge generated under the DeNPD through a green perspective (Fig. 4).

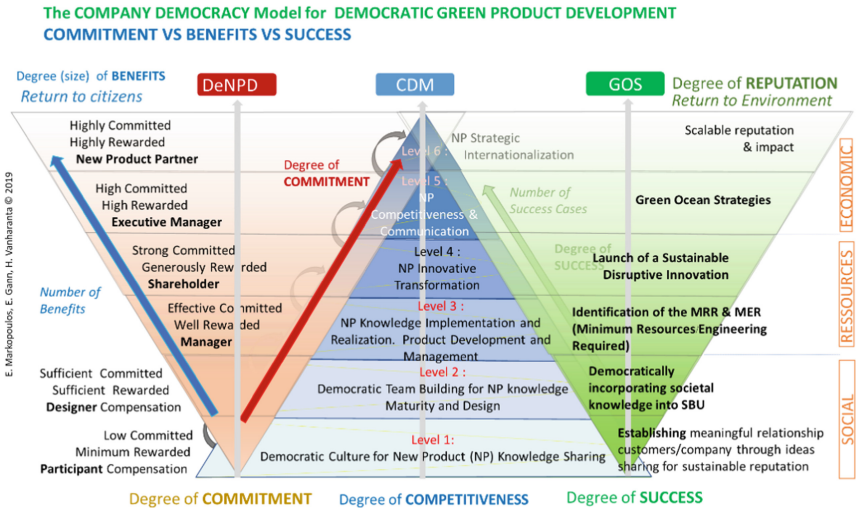

Fig. 4. The Democratic Green Product Development Model (DeGPD)

The citizens are encouraged to provide their green ideas and filter other ideas for their sustainability potential. Henceforth, ideas are not only valued by their profitability but also for their sustainability. The first level of the Green pyramid attempts to understand the green impact of a proposed new product. It is the state the product is introduced at a conceptual level and with limited impact due to the narrow contribution of the individual and its relatively small impact in the company. The second level democratically constructs the team around the product idea, which enables to further determine and define its environmental impact and integrate the individual more in the company. In Level 3, the product gets developed under a green view, which increases its impact on the environment and the reputation of the company respectively. In Level 4, the green product is placed in the market and based on the positive environmental impact generated through customer purchases, further research and development is conducted to enhance its innovative elements. In Level 5, the new, innovative product is strategically marketed to deliver the competitiveness gained by its extended positive impact and reinforce the green reputation of the company. Lastly, in Level 6, the product utilizes its competitive advantage of level 5 to penetrate international markets, scaling its impact and reputation furthermore.

The overall journey and cooperation of the individuals (citizens) and the companies are driven by a rewarding scheme that intensifies from level to level the contribution and commitment of both parties on this process, allowing the company to fully utilize the people's understanding and knowledge for successful green innovation. The DeGPD model aims to find green elements in blue innovations. The further an organization moves up the stages, the more green elements can be identified, elevating the environmental impact and organizational reputation. Eventually, the DeGPD model allows organizations to place themselves into the Green Oceans, achieving profitability and sustainability coherence that enables long-term viability and success.

8 Sustainable Green Capitalism

The terminology of Green Capitalism has been floating in the literature in numerous attempts contested and re-conceptualized over the last few years. However, there has not been a case where the term is being used under the integration of sustainability with profitability, which explains the criticism in the press [15, 16].

In one of these definitions, Green Capitalism is expressed as "a form of environmentalism that emphasizes the economic value of ecosystems and biological diversity and attempts to reduce human environmental impacts by ensuring that the importance of environmental services is reflected in the way that markets operate" [17]. On that basis, the judgment from economic journalism is understandable: the notion of sustainability here is neither comprehensive nor practical. Henceforth, in a book titled Green Capitalism, why it can't work, Smith states that "If by Green Capitalism we understand a system in which the qualitative, social and ecological parameters are taken into account by the numerous competing capitals, that is to say even within economic activity as an endogenous mechanism, then we are completely deluded. In fact, we would be talking about a form of capitalism in which the law of value was no longer in

operation, which is a contradiction in terms" [18]. The notion that long-lasting value creation is hydrophobic to capitalist can be possible rethought.

Beyond the literal common understanding of sustainability as ecological-friendly, corporate sustainability has to be understood as long-lasting value innovation. This is due to the fact that ecological sustainability can solely be achieved on the basis of corporate sustainability in regard to profitability, productivity and performance, allowing businesses to operate and impact the market in the long run. Since the 20th century, companies' mutation in size, geographical scope, and stakeholder integration makes them game-changers for the market and by extent for the society. The socio-cultural behavior co-evolves today under the company's omnipresence, which provides them with a degree of responsibility. Society's entities, movements, and other influence clusters drive indirectly company's actions. Under this perspective, successful companies have to mirror society and act as a possibilities revealing prism displayed under the innovation light. Therefore, companies can shift to sustainability as society, nations, and policies are acting towards.

It is, therefore, necessary for the academic literature to contribute towards establishing a definition consensus on the Green Capitalism term, meaning Sustainable Ecological Capitalism. This notion has to be a synonym to long-lasting value creation and scaled profitability from ecological initiatives, products and inventions.

Under this perspective, Green Capitalism needs to be redefined and reconsidered as a dimension of capitalism, aiming at organizational growth, productivity, profitability and performance, but also and simultaneously sustainable value innovation for the society, economy and environment, in which a viable company operates.

9 Conclusion

Green capitalism is not a contradictory term between activism and capitalism. In order to achieve environmental sustainability, it is important first to achieve corporate sustainability. In this relationship, capitalism links the positive development of companies with the positive development of the environment. It is a win-win relationship that needs to be embedded and accepted by both the activists, the ethical capitalists, and the profit-driven capitalists. To achieve this balance companies shall give more new products to the environment and the environment will then give more profits to the companies. Developing new green products benefits both the companies and the environment but, in this relationship, a third party is involved as an inflection point of the equation. The involvement of the citizen, the individual, is required in the development of these new green products. Today the individuals are more environmental consciousness than ever before can be the ultimate source of ideas for developing what can be bought while saving the planet. These new products can be achieved through the DeGPD, an extension of the DeNPD with the difference that the new products developed for green capitalism and shall be eco-friendly. The democratic concept of the DeGPD is based on the involvement of the society where actually anyone has the same opportunity to contribute intellectual capital towards the new definition of Green Capitalism. However, developing intellectual capital requires effort and energy that shall not be wasted. The Green Innovation Waste Management Protocol behind the

DeGPD reduces the waste of such energy and enables more green intellectual capital to be implemented and impact the market by offering more green products for the sustainability of the companies and the environment. Green capitalism is the integrated outcome of Red, Blue and Green Ocean strategy, the Company Democracy Model, and the Democratic New Product development adjusted for the Democratic Green Product development. All these are orchestrated under an Innovation Waste Management Protocol which assures that no green knowledge and contribution will be wasted. Green Capitalism is Capitalism. It is the new capitalistic thinking and acting that can return to the people, the economy and the environment.

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Information Management Strategies in Manual Assembly

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Abstract. In the light of a rising number of product variants and increasing dynamics of product modifications in industries such as vehicle and machine construction, the use of complexity management strategies in manual assembly is essential. In this paper different strategies are presented. In the age of digitalization, the strategy of providing cognitive support to assembly workers is highly important, and is therefore described in more detail with the help of morphological boxes. These boxes will support practitioners to develop a company-specific strategy for information management in manual assembly.

Keywords: Manual assembly · Complexity · Information management

1 Introduction

Often, designing manual assembly systems is associated with the question of how to manage the increasing assembly complexity to fulfill existing productivity, quantity and quality-related goals. The complexity of an assembly system increases with the number of different products and product variants to be assembled. In addition, complexity increases when the dynamism of product modifications accelerates and product life cycles become shorter [1]. In all these cases, employees face the challenge of having to complete a wide range of different choice and decision-making processes. Therefore, highly complex manual assembly tasks require employee support for such cognitively challenging choice and adaptation processes, especially as changing work tasks cause employees to forget how to operate individual process steps over the course of time (for instance for rare product variants). Even experienced assembly workers need help to fulfill frequently changing tasks. Experience from automotive assembly shows that assembly complexity significantly increases the risk of errors, rework and failure to meet productivity, quantity and delivery goals [2].

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2 Objectives and Methodology

Increasing complexity creates discrepancies between the demands on employees and their limited cognitive resources. Here it is assumed that with an increasing assembly task complexity – for example due to an expansion in the number of product variants – the employee's mental resources become more and more strained, resulting in the threat of mental overload [3]. In such cases, the employee's mental resources are not sufficient to master the level of complexity. Thus assembly errors and a reduction of assembly performance may be the result. The goal of this paper is to point out strategies for complexity management in manual assembly. These strategies help to manage highly complex assembly tasks and to avoid cognitive overload (Sect. 3). One of these strategies involves improved information management, and therefore cognitive support for employees (Sect. 4). This strategy is particularly important in the light of a trend towards using digital assembly assistance systems. To develop this strategy, the results of a two-day expert workshop involving 13 participants were analyzed and prepared using the morphological box method [4].

3 Strategies of Managing Complexity in Assembly

Over time, the importance of individual strategies for complexity management in manual assembly has changed. While focusing on strategies for simplification in the past, today strategies to support employees are becoming more important (Fig. 1). Simplification means that measures are being taken to avoid or reduce complexity. Support means that the complexity of the assembly task essentially remains unchanged from an objective standpoint, but employees receive cognitive support [5] so that the complexity becomes manageable.

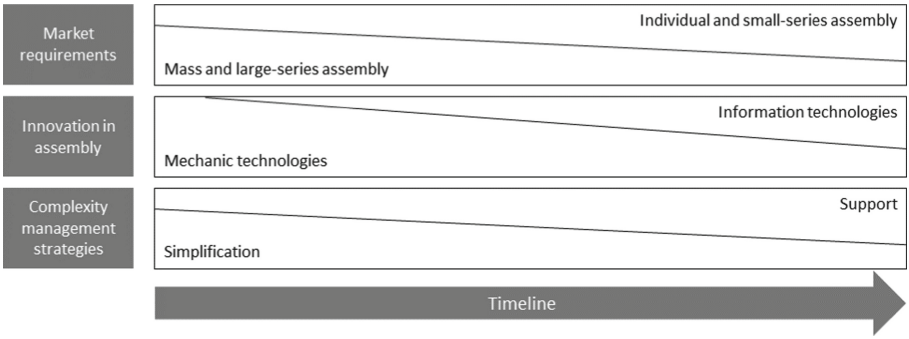

Fig. 1. Changes in the importance of individual complexity management strategies in manual assembly over time.

In the age of mass and large-series assembly, reducing complexity in assembly has been achieved by increasing the division of labor or through principles of batchwise

assembly. Consequently, it has been possible to develop routines, reduce search and orientation times, and increase employee performance [6].

With an increasing number of product variants, another strategy for complexity avoidance and reduction called modularization became important. This strategy is applied in the early phases of product creation. A modular product structure significantly reduces the diversity of components in assembly (e.g. platform strategy), without reducing the performance and product variety offered to customers [7]. In addition, implementing principles of product design in line with assembly requirements (design for assembly, for instance reducing the number of parts) also reduces complexity in manual assembly.

With the development of new information technologies, strategies of providing cognitive support to assembly workers are becoming more important (Fig. 1). One of these strategies, the strategy of information management, addresses the question of how information can be presented in a supportive way so that it can be perceived and processed effectively (error avoidance) and efficiently (short assembly times). For this purpose, for instance, it has to be analyzed how selection decisions are facilitated, how typical mental models can be considered, or how attention can be selectively directed to critical aspects of assembly. A detailed explanation of this strategy is provided in Sect. 4. Another supporting strategy associated with the strategy of information management is applied directly to assembly employees. This strategy includes setting up training plans and conducting assembly trainings.

4 Strategy of Providing Cognitive Support in Manual Assembly

The strategy of providing cognitive support to assembly workers includes, on the one hand, developing and providing assembly instructions. On the other hand, this strategy focuses on arranging and labeling tools, components, container, and equipment. Both sub-strategies are closely connected and must be coordinated with one another. Assembly instructions (sub-strategy 1) can be provided according to Fig. 2 via work papers or in digital form. Digital information presentation, in turn, can be static or dynamic (Fig. 2). Static information presentation is when an assembly manual exists for a product – for instance in the form of a pdf document – and is output on a screen. Information is provided in a dynamic manner if it is transmitted to employees based on their needs and particular situation, and the worker can interact with the information system. A technical system for dynamic provision of information is called an assistance system [8]. Assistance systems collect data through sensors and inputs and process the data to provide employees with the right information (“what”) at the right time (“when”) in the desired format (“how”) – depending on their need, based on their experience, or depending on their workload status [9–11]. Information may be output in a visual (optical), auditory (acoustic), or tactile-kinesthetic (haptic) format according to Fig. 2. Common visual output devices used in manual assembly include screens and tablets, light and laser projectors, and wearables. Wearables, in turn, can be classified according to the part of the body where they are worn. Currently, the head (“smart glasses”), hand (“smart glove”) and wrist (“smart watch”) are primarily relevant [11].

The manner in which assembly instructions are visually presented has a large influence on employee workload. Therefore, the question is which content ("what?") is to be provided in what manner ("how?") and at what time ("when?") (Fig. 2). When selecting the information provided ("what?"), it has to be ensured that only the necessary information is displayed in patterns that conform to expectations. The presentation of the patterns can either be identical for all employees, or the patterns can be adapted by the employees according to their needs. This individual adaptation can be carried out by the workers in the software of the assistance system and stored in their individual user profile. Another possibility for the individualization of the information presentation is that the assistance system analyzes the user behavior and provides hints for the adaptation of information patterns to the user (such as leaving out some information if the employee has a large amount of practice).

FEATURE	EXTENT OF THE FEATURE				
TYPE OF ASSEMBLY INSTRUCTION	Paper form			Digital form	
TYPE OF DIGITAL ASSEMBLY INSTRUCTION	Static (e.g. pdf document)			Dynamic (assistance system)	
TYPE OF INFORMATION OUTPUT	Visual (optical)		Auditory (acoustic)		Tactile-kinesthetic (haptic)
TYPE OF VISUAL OUTPUT DEVICES	Screen/ tablet	Light/ laser projector		Wearable	Others (such as sensor lights)
CONTENT OF VISUAL PRESENTATION (WHAT?)	Uniform information pattern			Information pattern depend on user preferences and features	
MODE OF VISUAL PRESENTATION (HOW?)	Images/ symbols/ markings	CAD drawings	Text notifications/ descriptions	Videos/ animations	Combinations
TIME OF VISUAL PRESENTATION (WHEN?)	Step-by-step instruction			Instruction by overview	

Fig. 2. Excerpt of a morphological box for designing assembly instructions.

There is a variety of options for how information is presented visually ("how?"). In practice, assembly instructions that combine image or CAD information with text information (such as notices) have proven effective [11]. With regard to the time aspect of information presentation ("when?"), two different concepts can be selected. In step-by-step instructions, the entire process is divided into individual activities. Information is output in a sequential manner. The employee is guided through the assembly process step by step using the assistance system. Another concept, in contrast, includes an overview presentation on a large display. Information on multiple process steps or on the entire assembly task is provided in one overview presentation. The advantage of this method of information delivery can be that employees – in contrast to the step-by-step instructions – have the freedom to use their preferred work method. The disadvantage is that non-productive orientation times occur.

Sub-strategy 2 focuses on arranging and labeling tools, components, containers, and equipment. Important design options are shown in Fig. 3. Components and tools can be arranged either by the sequence in which they are used and/or by their

belongingness to a category. In the first case, components or tools are arranged from left to right in the typical sequence in which they are used in assembly. In the second case, all work objects in one category (such as all required wrenches) are arranged beside one another or in a designated field, so that more "automated" behavioral patterns can be established (note: "automatically" executed actions can often result in inertia that prevents the necessary adjustments from being made for different product variants, resulting in more errors).

FEATURE	EXTENT OF THE FEATURE				
ARRANGEMENT OF WORK OBJECTS	Arrangement according to sequence of use	Arrangement according to common characteristics	Temporal stability of the arrangement		
CODING OF WORK OBJECTS AND LOAD CARRIERS	Visual	Haptic			
VISUAL CODING	Colors	Numbers	Letters	Patterns / symbols / images	Combinations
ORIENTATION FOR PLACEMENT AT THE JOINING LOCATION	Use of fixtures	Visual markings on the workbench			

Fig. 3. Excerpt of a morphological box for arranging and labeling work objects in manual assembly.

Work objects can be coded by haptic and/or visual means (see Fig. 3). For example, employees can be supported by the use of tactile (such as grip tape) and/or visual features (such as color coding of tools and containers with their matching screws) to pick up a hex key correctly. Visual codes may include colors, numbers, letters or symbols, for instance. In practice, combinations are often suitable. Employees must be able to notice and remember these codes (such as the code for the storage location of a parts container listed in the work instruction) as easily as possible. The use of assembly fixtures or markings on the workbench can provide orientation to employees, and help them to create stable behavioral patterns in assembly, even with its high amount of variance.

5 Conclusions and Outlook

In light of a rising number of product variants and increasing dynamics of product modifications, the use of complexity management strategies in manual assembly is essential. Here, the development of an operational strategy for the cognitive support of employees in manual assembly is of particular importance. The two sub-strategies for managing information provide a point of orientation to develop company-specific strategies for information management in manual assembly. In the future, the use of low-code programming will become more and more important in designing assembly assistance systems, since this fourth generation of programming language allows users

to develop assistance system solutions that meet requirements in a comparatively short time by involving employees from assembly and industrial engineering.

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Expression of Feelings in Twitter: A Decision Tree Approach

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Abstract. Studies that examined the relationship between expressing feelings, such as feeling 'bored', 'excited', 'lonely', loved', 'sad' and 'happy' and Twitter users' network size (i.e. the number of friends and the number of followers) did not take into account the influence of other factors, such as the number of tweets, the number of lists and the number of favourites, because prior research did not provide clues as to why these should be considered. The data mining approach is not biased by prior knowledge. In this study a data mining technique, specifically a decision tree, was applied to look at the interaction between the expression of feelings and all Twitter users' attributes considered likely to be useful in the discovery of interesting rules. The decision tree technique was applied on a large dataset of tweets containing the phrases, in double quotations marks, "I am bored", "I am excited", "I feel lonely", "I feel loved", "I feel sad" and "I feel happy". Only when these phrases were tweeted twice or more at different times that they were retrieved from Twitter using the Digital Methods Initiative Twitter Capture and Analysis Toolset (DMI-TCAT). The decision tree technique generated a number of interesting rules that provided clues about previously unknown relationships between the expression of feelings and a number of Twitter users' attributes. This study demonstrates that data mining is valuable for shedding light on previously unconsidered factors that can influence the expression of feelings; thereby advancing the research in this area.

Keywords: Twitter · Data mining · Knowledge discovery

1 Introduction

Feelings expressed in status updates can influence the size of a user's network [1]. Negative feelings expressed in tweets have been found to reduce network size, while positive feelings can aid the growth of a user's network [2]. Consistent with this, Al-Saggaf and Ceric's [3] examination of the relationship between the expression of boredom and excitement on Twitter and network size has revealed that users who expressed boredom had smaller network sizes, that is, their number of followers and number of friends were smaller, compared to users who expressed excitement. With respect to the relationship between the expression of loneliness, feeling loved, sadness and happiness on Twitter and network size, Al-Saggaf, Utz and Lin [4] have found that users who expressed loneliness had smaller network sizes compared to users who

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expressed feeling loved and users who expressed sadness had less friends than users who expressed happiness. Likewise, Brown, Roberts and Pollet [7] have found that participants with a larger network size reported significantly lower feelings of loneliness. Al-Saggaf, Utz and Lin [4] findings are also consistent with Dunder's et al. [5] findings. The reason for this is perhaps due to the negative connotation associated with expressing negative feelings in social media [4], i.e. being less attractive to a user's network [6]. But, a more recent study has revealed opposing findings to those reported above [8]; suggesting the literature is offering mixed findings. One of the problems with Al-Saggaf, Utz and Lin [4] and Al-Saggaf and Ceric [3] is that they compared the network sizes of users who tweeted a negative feeling with users who tweeted a positive feeling using one tweet and did not consider the impact of other user's attributes on this variable. This study will look at the interaction between expressing feelings, such as 'bored', 'excited', 'lonely', loved', 'sad' and 'happy', and network size while taking into consideration the influence of other factors (i.e. attributes of a Twitter user). The study will do so using a data mining technique specifically a decision tree.

2 The Data Mining Approach

Tweets were collected from Twitter in December 2016 over a period of eight days. The tweets were retrieved using the Digital Methods Initiative Twitter Capture and Analysis Toolset (DMI-TCAT)[1]. For the TCAT to work, an App was developed in Twitter to automatically authorise TCAT to retrieve data from Twitter on behalf of the author. To retrieve the tweets of users who explicitly expressed the above mentioned feelings, i.e. boredom, excitement, loneliness, feeling loved, sadness and happiness, the phrases "I am bored", "I am excited", "I feel lonely", "I feel loved", "I feel sad" and "I feel happy", in double quotations marks, were used. After downloading the data of interest, it was queried using SQLite for users who expressed these feelings twice or more. Only tweets for users who expressed these feelings with these criteria were stored in datasets and used in analysis. The loved and lonely datasets were first merged and a class attribute with two class values: "loved" and "lonely" was used. In the merged dataset, the class attribute values of the records from the loved dataset stayed as loved and the class attribute values of the records from the lonely dataset stayed as lonely. The above process was repeated for the happy and sad, and bored and excited datasets. That is, a dataset was created with records being labelled as either happy or sad, and another dataset was created with records being labelled as either bored or excited.

In order to build the decision tree from the above datasets, J48 implementation of C4.5 decision tree technique in WEKA was used. C4.5 is a classification algorithm that is suitable for pattern extraction and knowledge discovery because it builds a single tree that can easily by interpreted. A decision tree is a flowchart like structure that discovers a set of logic rules, where each record of a dataset (i.e. the dataset which is used to build the decision tree) falls in one and only one leaf (logic rule) of a tree.

[1] http://www.intersect.org.au/research-tools/tcat.

Along with the 'tweet', TCAT also returned the 'user id', 'the user name' (the handle of a Twitter user), 'to the user's name' (the mentioned user in a tweet using the @ symbol), 'the date' and 'time' the tweet was created, the 'user's language' (the language of a user as indicated by the user in their account), the 'source of the tweet', 'the user's profile image url', the 'tweet's language' (the language used in the tweet), 'the user's number of followers' (the number of Twitter followers a user follows), 'the user's number of friends' (the number of Twitter friends a user has), 'the user's number of tweets' a user has tweeted (since creating the account), 'the user's number of lists' (the number of lists a user is on), and 'the user's number of favourites' (the number of tweets a user favourited).

As some of the attributes were numerical and others were categorical, the datasets were split into two sets: one with the numerical attributes and the other with the categorical attributes. Altogether, six datasets from the three merged datasets were created (with class values loved and lonely; happy and sad; bored and excited). The following categorical attributes were considered likely to be useful in the knowledge discovery: the user's language and the tweet's language. The following numerical attributes were considered likely to be useful in the knowledge discovery: the user's number of followers, the user's number of friends, the user's number of tweets, the user's number of lists, and the user's number of favourites.

A 10-fold cross-validation was used and only results of models that achieved closer to 60% classification accuracy or above were retained. A number of logic rules were generated using J48, however, only rules with high support and confidence were reported. Support of a rule represents the ratio of the number of records following the antecedent of the rule to the total number of records in the dataset. Confidence of a rule is the ratio of the number of records in a leaf with the dominant class to the total number of records in the leaf.

3 Observations

3.1 Lonely and Loved Tweets

There were 147 users in this dataset. When the number of favourites was greater than 968, and the number of tweets was less than or equal to 25258, 52 users (35.37% of the total number of users) tweeted either feeling loved or lonely. Out of the 52 users, 43 users (82.69%) tweeted feeling loved. For the opposite feeling, when the number of favourites was greater than 968, and the number of tweets was greater than 25258, 22 users (15% of the total number of users) tweeted either feeling loved or lonely. Out of these 22 users, 13 users (59%) tweeted feeling lonely. This suggests that a larger proportion of users who expressed feeling loved tweeted less compared to those who expressed feeling lonely. Earlier research focused only on the impact of expressing feelings on the number of friends and followers. The message from these two rules is that the numbers of favourites and number of tweets also influence how a user feels or that how a user feels influences the number of favourites a user makes or the number of tweets a user posts. Further research is needed to shed light on this issue. Figure 1 below shows the decision tree generated for the lonely and loved tweets.

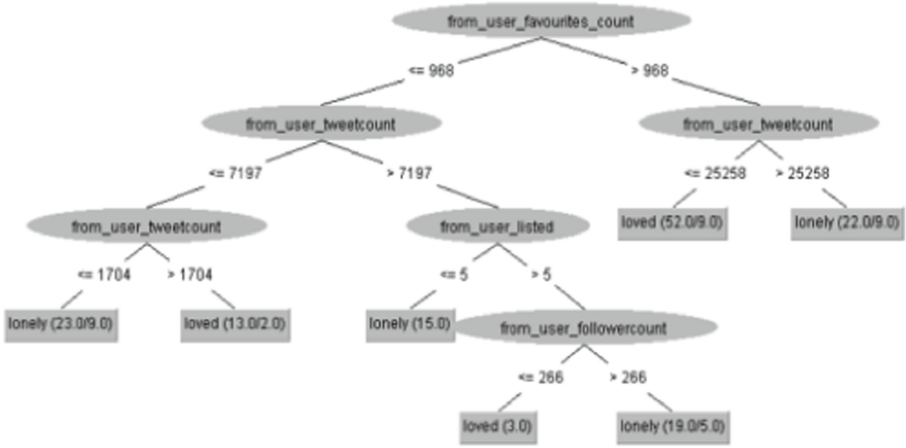

Fig. 1. Decision tree for the lonely and loved tweets

3.2 Bored and Excited Tweets

This dataset contained 668 records. When the number of friends was greater than 264.0, 344 users (i.e. 51.5% of the total number of users) tweeted either feeling bored or excited; and of these 344 users, 237 users (68.90%) tweeted feeling excited. For the opposite feeling, when the number of friends was greater than 264.0, 324 users (i.e. 48.5% of the total number of users) tweeted either feeling bored or excited; and of these 324 users, 171 users (52.7%) tweeted feeling bored. It appears that when a user's number of friends is high, the chance that a user reports feeling excited is also high. On the other hand, there is more than 52% chance that a user with a smaller number of friends may report feeling bored. Figure 2 below shows the decision tree for the bored and excited tweets.

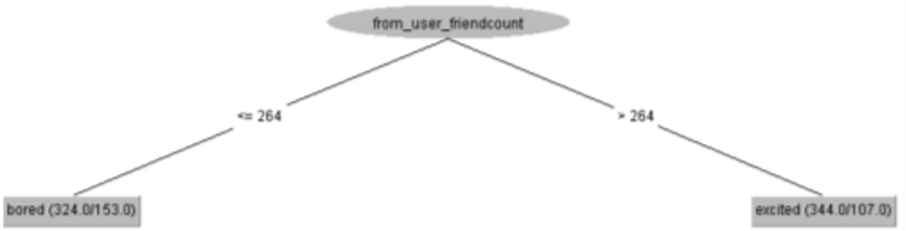

Fig. 2. Decision tree for the bored and excited tweets

3.3 Happy and Sad Tweets

The J48 generated interesting rule relating to users' language for happy and sad tweets the dataset, which contained 349 records. When a user's language was English, 319 users (i.e. 91.40% of the total number of users) tweeted either feeling happy or sad; and

out of these 319 users, 219 users (68.65%) tweeted feeling sad. This rule suggests that when a user's language is English then there is chance that a user would tweet feeling sad. Figure 3 below shows the decision tree for the sad and happy tweets.

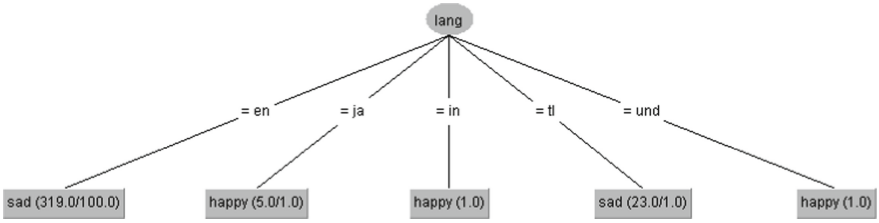

Fig. 3. Decision tree for the sad and happy tweets

4 Conclusion

Previous studies that compared users who tweeted a negative feeling with users who tweeted a positive feeling and the effect of these expressions on their network sizes did so using a single tweet and without taking into consideration the impact of other factors. In line with the data mining approach which does not require domain knowledge to reveal patterns about expression of feelings, this study did not look at the effect of expressing feelings, such as 'bored', 'excited', 'lonely', loved', 'sad' and 'happy', on network size because doing so would mean there was a relationship between the expression of feelings and network size to be found. Rather, using a data mining technique, specifically a decision tree, this study looked, without the assumptions of previous research, at the interaction between the expression of feelings, "I am bored", "I am excited", "I feel lonely", "I feel loved", "I feel sad" and "I feel happy" twice or more at different times, and all Twitter users' attributes considered likely to be useful in the knowledge discovery, such as number of friends, number of followers, number of tweets, number of favourites. This demonstrates that data mining can shed light on previously unconsidered factors that can influence the expression of feelings.

The J48 discovered a number of interesting rules about the expression of feelings in Twitter based on these users' attributes. For users who tweeted "I feel lonely" and "I feel loved" twice or more at different times, if the number of favourites was greater than 968, and the number of tweets was less than or equal to 25258, then there is 82.69% chance that the user would tweet feeling loved. In contrast, if the number of tweets was greater than 25258, then there is 59% chance that the user would tweet feeling lonely. It appears from these rules that tweeting on a regular basis may make users feel lonely or that loved users tweet less compared to lonely users.

For users who tweeted "I am bored" and "I am excited" twice or more at different times, if the number of friends was greater than 264, then there is 68.90% chance that the user would feel excited suggesting that when the number of friends is high, the chance of feeling excited is also high. For users who tweeted "I feel sad" and "I feel happy" twice or more at different times, if a user's language is English then there is chance that a user would tweet feeling sad.

Two limitations must be acknowledged. (1) Data collection occurred around Christmas time, this may have influenced the findings. Although this may not be a limitation per se because people are often clearer about their feelings during Christmas time, a future study should collect data during diffident periods of time to ensure the findings are not specific to a certain period of time. (2) Only tweets that expressed these feelings using the phrases "I am bored", "I am excited", "I feel lonely", "I feel loved", "I feel sad" and "I feel happy", in double quotations marks were retrieved. Feelings expressed in tweets differently such as "very sad today" were not retrieved. This was done to achieve consistency when comparing the various feeling groups and also because it is difficult to think of all the possible ways people use to express such feelings. However, a future study should use data mining algorithms to first classify tweets into emotional categories and then conduct these analyses.

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How Can We Rescue the User from the Digital Transformation Tornado?

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Abstract. Digital Transformation affects our lives in many realms. It is a way to help consumers and users get rid of intermediaries - those people whose jobs are to connect consumers to final products or services - such as salespeople, bank agents, mediators. Now consumers can do things independently using diverse software: for example, they can shop without the help of salespeople on an e-commerce and carry out transactions on an e-banking without a bank agent. The problem is that they are often left to wonder how to use these digital resources properly, getting lost in a tornado of clicks, typing and interfaces. And ironically, they have to establish new intermediary resources to use digital technologies: manuals, trainings, help desk tickets, which are often outside the digital sphere. In this paper, we propose a reflection on how to assist the user, rescuing their independence and confidence while keeping them in the digital realm.

Keywords: Knowledge management · Innovation management · Digital transformation · Entrepreneurial learning · Management in education

1 Introduction

On Forrester's report [1] we read that 21% of North American and European enterprises think their Digital Transformation is done.

While half of the world is fully immersed in making Digital Transformation happen and the other half says that it has already happened, almost no one thinks of the agents behind the phenomenon, the people we will refer to as digital transformers, and their ultimate goal.

The purpose of this article is to analyze this goal and to arrive at a clearer overview of digital transformation and its consequences for users of digital resources, especially software, as well as the ever growing pressure these users withstand in the process.

In the digital realm, users are encircled in a cage full of clicks, traps and hidden paths, with hurdles to be overcome, just to execute apparent simple tasks and find a way out of what we call digital tornado. They surely need some help to go through this, or digital transformation risks being highly ineffective or even failing. In this article, we are going to reflect upon this and the rise of a new kind of technology, the overlays.

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2 Digital Transformers Identity and Goals

Digital transformation is often thought of as an anonymous process, but it is instead a phenomenon which is carried out by active agents. Here we will focus on one of these agents: the digital transformer, a visionary who has good ideas which become popular and transform human processes and interactions into something digital.

Anybody who works in designing or building Digital Technologies is surely part of the digitalization process, but a Digital Transformer is, at first, a visionary who turns everything into a device managed by lines of code.

To describe it in a few terms, turn your head around and look at the first thing which is close to you. Then, try to imagine how to transform it into something digital: this is the essential thought which can turn you into a digital transformer. To provide an example, I can use the handle of my window. It could have some kind of automation, so I could open and close it with my mobile phone while sitting on the couch. Thinking a bit further, I could even invent some sensor which is able to scan my skin, and open the window when I start sweating. This process is potentially endless.

However, being a Digital Transformer does not directly imply that you will make easy money out of the phenomenon of Digital Transformation. As monetisation is the lead driver of any innovation, the first successful Digital Transformers quickly understood that Digitalisation could turn into easy money by shortening the distance between the source of the product or service and their end consumers or users.

Taking a look at the past years, and you will find plenty of examples: e-commerce, which cancelled the need to stroll around malls to go shopping; internet banking, which allowed you to check your balance every minute and perform operations without going to the bank in person; e-bay, opening up the possibility to sell your unnecessary items by yourself… and others more.

3 No More "Man in the Middle": How Digital Transformation Chases All Intermediaries

In some way, Digital Transformers shorten the distance between products and consumers, but they could also be seen as those who fired and hunted anybody who stands between people and the product or service.

Here are the facts: Booking.com reduced the number of travel agents, AirBnB reduced the scope and the number of Real Estate agents, Internet Banking changed the job of many bank officers, chatbots are reducing the number of support desk specialists (We foresee that 85% of customer interactions will be performed by bots in 2020) … and the list can go on for a while [2].

So, if you decide to become a successful Digital Transformer, just look around and find any agent, mediator, service man, or anybody who stands between a product or service and yourself. Now make him or her digital, and you will have a very good start towards your goal.

Considering that turning something digital is most of times not an easy task, we can anyways state that Digital Transformation is based on eliminating the "man in the middle", and that it is replacing intermediaries with portals, smart devices, bots and others, more and more. In nature, we find the "horror vacui", which is the fear of empty spaces. Digital Transformation comes from the "horror medium" of our times, the fear or repulsion of/for intermediaries. They are often seen as unnecessary, someone who slows down access to the final product or service and which makes them more expensive at the same time.

4 Unpleasant Consequences of the Imperfect Replacement of Intermediaries

Many may say that all of this is a matter of human progress, something which has been widely observed during the last century: cars replaced horses, and thus replaced all the business which relied on animals for transportation. However, today's impacts are wider, due to the structure of the contemporary society. Apart from putting product and customer in touch, there are two things that the agent or "man in the middle" does (or used to do):

- They look at the product or service and inform the customer about it;
- They interact with the customer and provide feedback to the producer.

All of this is (or used to be) useful information which Digital Transformers might forget, or just not to consider important… or even completely ignore. Here are some examples: recommendations about the most appropriate product for the user, or about the most efficient way to use the product, recommendations to producers, focusing on how to improve their product. In some fields, it is particularly evident that human sensibility is needed and definitely makes the difference. Numbers support it: an American Express article states that 40% of customers prefer talking to a real human on the phone when it comes to complicated issues [3].

Quite every worker who mediated the demand with the supply is (or was) an expert in the processes, procedures and products in question. As an example, before, when you needed to check your bank account balance, you could ask your agent.

Now to make the same transaction, I have to open an app. This is a typical scenario: "Oh, I got a message saying it needs to be updated. Of course, I need to type my user ID once again… and the password after the update. OK, the new version of the app looks beautiful. But where is my balance? Ok, select which bank account… in the end, apart from having had a cold and lonely interaction, our user took a long time to figure out how to carry out this task.

The dramatic consequence of Digital Transformation is that many "men in the middle" are disappearing and their jobs are, at least partially, moved to users. In the future, 9 out of 10 jobs will require digital skills. But reality is that 44% (169 m) of Europeans between 16 and 74 years old still do not have basic digital skills - and we are talking about Europe, which is an important player of economic welfare and has privileged access to the latest technology [4]. At the same time, even when digital skills are present, technology is still not able to cover all what has gone with intermediaries. And even when it does so, the human element is often missing.

As mentioned, whereas an intermediary can perform a routine task in terms of seconds, it will take at least a few minutes for users to perform the same task, as they have to figure out processes which are unfamiliar to them in order to obtain the same information. The reality is that digital transformation brought about not only digital resources, but along with it, lost users.

5 Are Intermediaries Really Gone?

Commenting on the fact that people are always clicking through their smartphones is a banal consideration nowadays. It is definitely true that most of us are curving our backs in front of the screen because of social networks, but this could also be because we are trying to perform operations which were performed by somebody else in the past.

Sometimes, many of the things we are now in charge of doing (creating an account for a utility, for example, purchasing a ticket for the theatre or booking a Journey to some European capitals) cannot be performed via a smartphone (or they are, but in a very unpleasant way) so we turn on the computer and try to find our way through portals and web applications.

Which options do we have when we feel lost? We may call the support desk, browse a user community, read some blogs, watch a how-to video… Sometimes even read a manual.

In some way, we need training and guidance to finally complete these tasks and escape from these digital traps. So that we can devote our time to more pleasant activities. Ironically, to get by with digital technologies and services, we are adding new intermediaries to the processes: a Youtuber, a support chatbot, a help desk operator. Digital intermediaries. Their implementation, in turn, requires highly skilled workers.

6 Affording Digital Mediators Using Overlay Technology

The summary of the story is the following:

- successful Digital Transformers were and are eliminating mediators
- the user is lost in tasks normally performed by mediators
- there are new mediators used just to make users understand and use digital resources

This is quite funny. But in reality, not so funny for Digital Transformation. The phenomenon is now looking at itself and defining digital ways to eliminate the resources which connect digital transformation and enable people to use chatbots, platforms, applications, i.e. manuals, trainings, help desks.

We now know well how Digital Transformation works. All the services which mediators used to provide now take place in the digital realm, and are now responsibility of the user. The same logics apply at the user level: the user, getting lost and frustrated when trying to figure out how to actually perform these digital tasks, now needs to enable new intermediates to get by. Manuals, trainings and call centers, which take the user forth and back from the digital sphere, are the new “men in the middle”.

But as discussed, digital consumers and users do not like intermediaries. So it comes as no surprise to find out that a replacement for them is already available. We call it "Overlays" or "Overlay technology", such as Newired. It is the final strike of digitalization, which is transforming all these intermediaries and bringing them to the digital realm. Using digital to explain and guide digital.

The beauty of this kind of solution is that, differently from other human or technical mediator, overlays provide their services in place, exactly where and when they are needed. And often in a more appealing way to the users, making them self-sufficient and confident and without involving other people and resources. This is more and more appreciated by digital users: to provide some numbers, Americans, prefer solving basic customer service issues through a self-service website or app [3].

If you get a "classical" training, you get information earlier than when you need them.

If you read a PDF manual, it is outside the application you are using.

If you get guidance on the phone, it takes a long time for the support person to understand where you are and to give you instructions with verbal descriptions, outside the application.

Overlay Technology software make it possible to bring all useful information directly into the application, so that all users, even beginner ìones, will find their way in the application.

7 Conclusions

The road is still long to a time where all digital resources will be perfectly integrated into our society and seen as a natural part of our routine. According to a report from Forrester [5], only 5% of organizations say they have mastered digital to a point of differentiation from their competitors. At the same time, Seagate says that two-thirds of global CEOs will start focusing on digital strategies to improve customer experience by the end of 2019 [6]. All this means that Digital Transformation is still running and it is just getting started, spreading into the service sphere as well.

Often, companies invest heavily on implementing software to manage their resources and their interactions with their employees and customers, and this gives them a sense of "accomplished duty" when it comes to going digital. However, adopting digital software and eliminating "useless" intermediates is not enough. If we do not enable users to get by in the digital realm, other intermediaries will appear, in the form of manuals, support centers and training sessions. Because users are, first and foremost, human, with needs, expectations and problems to solve. Bringing in digital resources without due consideration to the human factor results in frustration and failure. After all, there is no use in investing on software which nobody is going to adopt, because it is too hard to figure out.

But at the end of the day, digital consumers and users still do not like intermediaries, so we see a new development in digital transformation. It is striking and transforming all the resources which are outside the digital, offering help and support to users with overlay technology. It is digital transformation looking at itself and eliminating the last "men in the middle".

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The Right to Reparations: A New Digital Right for Repairing Trust in the Emerging Era of Highly Autonomous Systems

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Abstract. This paper argues that a new digital right, the 'right to reparation', is needed to address the accountability gap presented by highly autonomous complex systems (HACS) incapable of fully monitoring their actions in real-time due to the increasing complexity of these advanced systems. The 'Right to reparation' follows the articulation of the 'Right to be forgotten', the 'Right of access' or more recently the 'Right to Reasonable Inferences', and aims to ensure that emerging HACS interactions remain accountable as current highly autonomous technologies cannot fully guarantee the effect of their behaviors. Building from an integrative review of previously published surveys specifically designed to address the rising concerns of artificial intelligence in the context of HACS, this paper presents indications by which introducing reparation and accountability strategies increase trust and engagement in the system in the context of unexpected events. Thus, building a case for the introduction of the newly proposed digital right.

Keywords: Human factors · Human-systems integration · Systems engineering · Digital rights · Ethics · Reparation · Accountability · Highly autonomous complex systems

1 Introduction

Skepticism and a lack of trust in AI has increased recently with citizens believing that the overall system is neither accountable nor transparent. To rebuild trust and restore faith in the system, some experts suggest that institutions must step outside of their traditional roles and work toward a new, more integrated operating model that puts people and the addressing of their fears—which mainly revolve around technological developments in artificial intelligence—at the centre of everything they do.

In this context, recent developments in computing prompted Peter Hancock to raise a warning to the human factors community by which attention must be focused on the appropriate design of a new class of technology: Highly Autonomous Systems (HAS) [1].

With the development and combination of machine learning and deep learning techniques a new paradigm is emerging; Machine-Human-Interaction (MHI). In this

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paradigm, technology controls the initiation of interaction. This approach positions highly autonomous systems at the centre and tries to address the implications of trust from their perspective [2]. Traditionally, HACS required the human operator to appropriately calibrate their trust in the automation in order to achieve performance and safety goals. However, a recent statement from DeepMind, the most advance AI company in the world states that "No amount of testing can formally guarantee that a system will behave as we want. In large-scale models, enumerating all possible outputs for a given set of inputs…is intractable due to the astronomical number of choices for the input perturbation" [3]. Recognising the impossibility of fully calibrating HACS, the authors note the challenge and propose the 'Right to reparation' as a human-centred strategy directly aimed at ensuring that emerging HACS interactions remain accountable to the user's needs and preferences.

This paper argues that a new digital right, the 'right to reparation', is needed to address the accountability gap presented by highly autonomous complex systems incapable of fully monitoring their actions in real-time. The 'Right to reparation' follows the articulation of the 'Right to be forgotten' [4], the 'Right of Access' [5] or more recently the 'Right to Reasonable Inferences' [6], and aims to ensure that emerging HAS interactions remain accountable while the development of highly autonomous technologies cannot fully guarantee their behaviours. Building from an integrative review of previously published surveys specifically designed to address the rising concerns of artificial intelligence in the context of Highly Automated Systems [6, 7], this paper presents indications by which introducing reparation and accountability strategies increase trust and engagement in the system in the context of unexpected events, these results build a case for the introduction of the newly proposed digital right.

2 Method

A preliminary co-design workshop with students from the Royal College of Art was structured to analyse the emerging concerns of Highly Automated Complex Systems where we wouldn't be able to fully guarantee their behaviours via a case study of Virtual Assistants (VA). It was approached from a consequential perspective to underpin its implications.

This activity underpinned two fundamental elements. On one side the four main highly sensitives areas where HACS may impact users significantly. As a result health and wellbeing, identity, economically related activities and social interactions emerged as the most highly sensitive areas. On the other hand, four major unintended consequences; unhappy services, wrong predictions, unintended losses related to the service and actions unexpectedly ending violently emerged (Fig. 1).

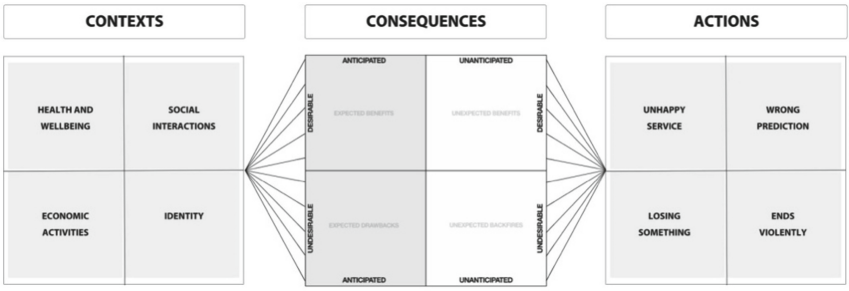


Fig. 1. Co-design workshop outputs - Fernando Galdon

From the areas aforementioned and based on demos, patents and prototypes, eight case studies were built to address different contexts and unintended consequences (Fig. 2). Two cases addressed each highly sensitive area ranging from low to high impact. Then, a survey was designed to establish whether a posteriori strategies such as reparation and accountability in highly automated virtual assistants were relevant to address the rising concerns of HACS for each case.

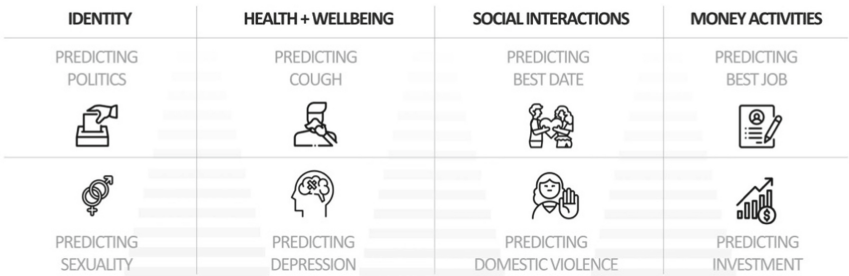
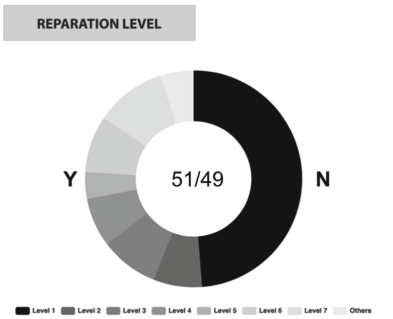
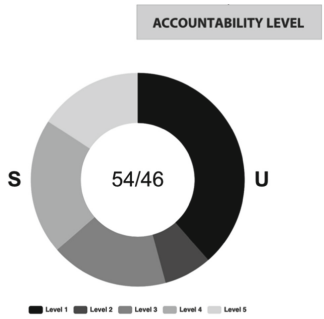


Fig. 2. Case studies distribution - Fernando Galdon

Participants were asked two questions for each case;
+ the VA predicts … but something goes wrong … who would be accountable?
+ the VA predicts … but something goes wrong … what would be the right level of reparation?

The survey was answered by 50 participants including 21 men, 27 women and 2 who didn't want to gender identify. They represented 14 different nationalities with an age range between 18–67 years old from different professions. The survey was live for four weeks and distributed to maximise a robust distribution via dissemination with relevant profiles and relevant forums.





REPARATION

AREA	UNHAPPINESS medicine	UNHAPPINESS newspaper	END VIOLENCE addiction	END VIOLENCE rape	WRONG PRED. sexuality	WRONG PRED. jailed	LOSE SMTHG. money	LOSE SMTHG. job	TOTAL
LEVEL 1 No reparation	**36%**	**48%**	**56%**	**64%**	**46%**	**56%**	**40%**	**44%**	48.75%
LEVEL 2 Basic apology	10%	8%	10%	6%	10%	4%	4%	6%	7.25%
LEVEL 3 Personal apology	22%	12%	2%	0%	24%	2%	2%	6%	8.75%
LEVEL 4 Public apology	6%	20%	6%	4%	4%	4%	6%	8%	7.25%
LEVEL 5 Low compensation	6%	2%	4%	4%	2%	0%	10%	4%	5.00%
LEVEL 6 Medium compensation	6%	0%	10%	2%	10%	8%	14%	18%	8.50%
LEVEL 7 High compensation	4%	6%	10%	12%	2%	20%	20%	10%	10.50%
OTHER ...	10%	4%	2%	8%	2%	6%	4%	4%	5.00%

ACCOUNTABILITY

AREA	UNHAPPINESS medicine	UNHAPPINESS newspaper	END VIOLENCE addiction	END VIOLENCE rape	WRONG PRED. sexuality	WRONG PRED. jailed	LOSE SMTHG. money	LOSE SMTHG. job	TOTAL
LEVEL 1 Platforms	20%	26%	12%	6%	14%	22%	18%	8%	15.75%
LEVEL 2 Designer	18%	**28%**	18%	14%	22%	24%	32%	8%	20.50%
LEVEL 3 Algorithm	16%	20%	8%	6%	**38%**	**30%**	16%	8%	17.755
LEVEL 4 User	**38%**	24%	**56%**	**38%**	24%	22%	**34%**	**74%**	38.75%
OTHER ...	8%	2%	6%	36%	2%	2%	0%	2%	7.25%

Fig. 3. Survey results - Fernando Galdon

3 Discussion

Building from the eight case studies aforementioned, in average 48,75% of participants did not demanded any type of reparation as part of interacting with Highly Automated Systems in Highly sensitive areas. However, 51,25% of the participants demanded some type of reparation strategy. In this context, 23.25% of participants would accept some sort of apology, and 23.00% in average would demand some kind of compensation to repair their trust in the system. The remaining 5,00% demanded a combination of apology and compensation (Fig. 3)

In terms of accountability, in average from the eight case studies addressing unexpected consequences in the interaction, 46% placed the accountability out of the system, 38.75% place the accountability in the user, 7.25% placed it in third parties delivering the service (for instance a pharmacy delivering some drugs to customers) and, 54% of participants placed the main accountability on the system side. Specifically, 20.50% of participants pointed to designers/developers, 17.75% pointed to the algorithm, finally, 15.75% pointed to the platform as accountable (Fig. 3).

The survey aimed to understand whether unexpected consequences derived from unsupervised Highly Autonomous Complex Systems where we cannot guarantee its behaviour/output affected users trust and engagement, to understand whether a posteriori reparative strategies such as reparation and accountability could provide a framework to address the rising concerns in these systems.

From the surveys conducted, contexts (highly sensitive areas) and actions (unintended consequences) played a role in determining user engagement. The 50/50 in average split presented by this research presents an empirical need for approaching the design of these system equally from preventive a priori strategies around simulation and calibration strategies to reparative a posteriori strategies around accountability and reparation.

These results present indications by which introducing reparation and accountability strategies increase trust and engagement in the system in the context of unexpected events. Thus building a case for the introduction of the newly proposed digital right.

4 Conclusion

In the results presented, the authors recommend the articulation of ‘the right to reparation’ to successfully build, maintain and repair trust in highly autonomous complex systems. This paper argues that this new digital right, the ‘Right to reparation’, is needed to address the accountability gap presented by highly autonomous complex systems incapable of fully monitoring its actions in real-time. The ‘Right to reparation’ follows the articulation of the ‘Right to be forgotten’, the ‘Right of access’ or more recently the ‘Right to Reasonable Inferences’, and aims to ensure that emerging HACS interactions remain accountable while the development of highly autonomous technologies cannot fully guarantee its behaviour.

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Work-Compatibility Based Accident Prediction Model for the Workforce of an Underground Coal Mine in India

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Abstract. Mines are dynamic and hazardous; because of these characteristics along with semi mechanised working procedure, accidents are occurring in Indian underground coal mines mainly due to ill performance of the workforce. It is challenging for the supervisors to achieve optimal work output with an acceptable level of quality and safety. Many studies have reported that work-related factors play a significant role in influencing the level of human performance with safety. This study aims to predict the chance of occurrence of an accident concerning the work-related factors and employee demographics. These objectives were achieved by using modified work compatibility (WC) and binary logistic regression models. We have achieved an inspiring level of accuracy on testing the model with the available data.

Keywords: Human performance · Work compatibility · Logistic regression · Accident · Safety · Mining industry

1 Introduction

Mining is an important sector in the Indian economy [1, 2]. But the mining industry is associated with high rates of occupational injuries and fatalities [3, 4]. Due to its dynamic and hazardous characteristics, mining is considered to be the high-risk professions. Despite all the significant improvements in mine safety, it remains one of the most intrinsically hazardous occupations in the world [5].

Most of the underground coal mines in Indian are semi-mechanised and primarily depends on the workforce for its operation. Many studies approve that errors committed by man contribute to 60–90% of the mine accidents; the remainder is attributable to technical deficiencies [6, 7]. The incidents/minor faults due to ill human performance can also seriously reduce the operational performances in terms of productivity and efficiency [8].

According to Genaidy et al., human performance is influenced and can be manipulated with a balance between demand and energiser. These parameters depend on several work-related factors [9–12]. In the present day, Indian mining situation work-related factors pose a challenge to the working employee performance [13]. So, it is an important concern to mine managers and safety engineers to associate work

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related factors to human capabilities for optimal work output with acceptable quality and safety.

In this study, we adopted Genaidy's work compatibility model and modified it to mining scenario, and collected the corresponding data from individuals working in two coal mines. Analysis of these data identified the significant factors that influence the human performance and their relation with the accident occurrence was studied through logistic regression model. And finally, we suggested some ways for improving human performance as well as productivity and safety.

1.1 Work Compatibility Model (WCM)

It is a multi-dimensional analytical tool for measuring human performance and can be used for optimising human performance in an organisation to create healthy work-places. It seeks a balance between energy depletion (demand) and replenishment (energise) and identifies the elements of better performance and parameters requiring intervention for the safer workplace [9–12, 14, 15]. Demand is a work characteristic which decreases the energy of the worker while energiser replenishes the strength of the worker.

This research uses the modified work compatibility model comprising 12 work-related factors (Fig. 1) and three demographics. It hypothesised that the higher is the WC, the better is the human performance, such as fewer work accidents and injuries/ illness, higher productivity, quality and work satisfaction [9, 11]. This study uses a linear work compatibility model (WCM) that measures compatibility as the difference between the demand and the energiser. Furthermore, we recognise a correlation between the variables which shows that the higher the energiser and the lower the demand, the higher is the compatibility.

$$\text{Compatibility} = \text{Energiser} - \text{Demand} \tag{1}$$

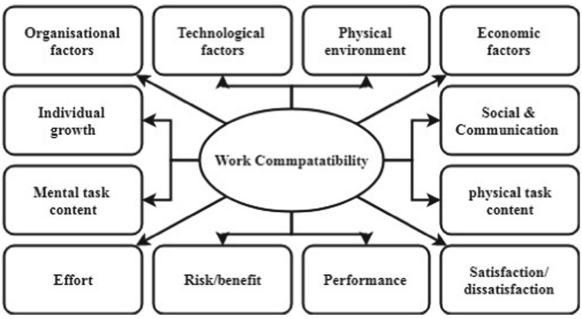

Fig. 1. Schematic representation of the work compatibility factors [10–12]

1.2 Logistic Regression Model

Complex logistic regression is an established technique for predicting the occurrence probability of the event of interest for multiple predictors using the following equations:

$$\text{logit(y)} = \ln\left(\frac{p}{1-p}\right) = \text{a} + b_1x_1 + b_2x_2 + \ldots b_nx_n \tag{2}$$

$$p = \frac{e^{(\text{a}+b_1x_1+b_2x_2+\ldots b_nx_n)}}{1+e^{(\text{a}+b_1x_1+b_2x_2+\ldots b_nx_n)}} = \frac{1}{1+e^{-(\text{a}+b_1x_1+b_2x_2+\ldots b_nx_n)}} \tag{3}$$

This study has used a binary logistic model and the multinomial logistic model as the dependent variable is dichotomous (an accident occurred or not occurred) [16–18].

2 Steps of the Proposed Methodology

Step 1: Development of a modified WC model apposite for underground mines.
Step 2: Selection of case study system.
Step 3: Collecting the required data.
Step 4: Testing the internal consistency of the collected data using Cronbach's alpha and coding the data for use in the logistic regression model.
Step 5: Identifying the factors significant for the accident occurrence and establishing the relationship between these factors with the accident occurrence.
Step 6: Recommendation based on the findings.

3 Application of the Proposed Model

3.1 Graphical Representation of Logistic Regression

The objectives of this study are fulfilled through case studies into two underground coal mines in India which reported a comparatively higher rate of accidents primarily due to ground movement, operating machinery and dangerous workplace environment in the recent past. One of these mines is located in the central part of India and operating with 150 (30 supervisor and 120 workers) underground workforces when the other one is in the southern part of India and has 140 underground workforces (30 supervisors and 110 workers).

This study has used data collected from 110 employees of the two case study mines. We have recorded the response of each participant on a Demand-Energiser Instrument (DEI) questionnaires booklet and accident response sheet specially designed for this purpose. DEI questionnaires booklet contains 85 questions about 12 work-related factors for both demand and energiser. Every subject has marked his response in a 5-point influence scale (from 1 to 5) based on his perception. The questionnaires booklet also collects three demographic information of the subjects and the accident response sheet encompassing the accident statistics and effects in terms of getting an injury at work.

3.2 Data Preparation for the Study

Calculated Cronbach's alpha values show that the collected data are internally consistent and suitable for using in a model development. Employees' demographics are categorised using the k-mean clustering technique. Age is grouped into three categories; (i) less than 30 years: Age_1, (ii) between 30 to 40: Age_2, (iii) more than 40 years: Age_3. Experience is also grouped into three categories (i) less than 5 years: Exp_1, (ii) between 5 to 15 years: Exp_2, (iii) more than 15 years: Exp_3.

Before regression analysis, it is necessary to add categorical variables to employee demographics and choose the reference category. In this study, worker (Deg_2) is taken as reference variable and results refer to supervisor (Deg_1). Similarly, Age_2 is the reference variable and results refer to Age_1 and Age_3. For experience parameter, Exp_2 is the reference variable and the results refer to Exp_1 and Exp_3. Regression analysis was done in SPSS using the code given in Table 1, when chance of getting an accident is coded as 1 and not getting as 0.

Table 1. Categorical variables coding's

Employee demographic group			Frequency	Parameter coding	
				(1)	(3)
Experience	Exp_1	<5 years	45	1	0
	Exp_2	5 to 15	30	0	1
	Exp_3	>15 year	31	0	0
Age	Age_1	<30 year	33	1	0
	Age_2	30 to 40	29	0	1
	Age_3	>40 year	44	0	0
Designation		Supervisors	38	1	
		Worker	68	0	

3.3 Regression Analysis

The result of the regression analysis is presented in Table 2. It shows that four work related factors, namely, Technological factors, Physical environment, Physical task content, and Effort are the most statistically significant ($p < 0.05$) factors for meeting an accident by an employee. The developed model is 95% satisfying the output results with the dependent variable. Equation developed through regression analysis is given below. Equation (4) estimates the chances of getting an accident by the workforce of a mine with 95% confidence.

$$
\begin{aligned}
&Logit(accident\ occurred)\\
&\quad = -3.14 - 0.044 * Deg_1 - 1.164 * Age\_1 + 0.580\\
&\quad * Age\_3 + 1.650 * Exp\_1 + 0.558 * Exp\_3 - 0.116\\
&\quad * Or - 0.863 * Te - 2.751 * Pe - 0.363 * Ec + 0.199\\
&\quad * Id + 0.14 * Sc - 0.453 * Mn + 1.739 * Pt - 0.657\\
&\quad * Ef + 0.191 * Rb - 0.225 * Pf - 0.911 * Sd
\end{aligned} \tag{4}
$$

Table 2. Result of regression analysis

Work-related factors & employee demographics	B	df	Sig.	Exp (B)	95% C.I. for EXP(B)	
					Lower	Upper
Exp_2		2	0.191			
Exp_1	1.650	1	0.069	5.206	0.880	30.778
Exp_3	0.558	1	0.543	1.747	0.289	10.544
Age_2		2	0.274			
Age_1	−1.164	1	0.163	0.312	0.061	1.600
Age_3	0.580	1	0.519	1.786	0.306	10.422
Designation (Deg_1)	−0.044	1	0.949	0.957	0.246	3.713
Organisational factors (Or)	−0.116	1	0.823	0.890	0.323	2.455
Technological factors (Te)	−0.863	1	0.031*	0.422	0.192	0.925
Physical environment (Pe)	−2.751	1	0.001*	0.064	0.014	0.302
Economic factors (Ec)	−0.363	1	0.394	0.696	0.302	1.602
Individual Growth (Id)	0.199	1	0.520	1.220	0.666	2.236
Social & Communicational (Sc)	0.140	1	0.821	1.151	0.342	3.865
Mental task content (Mn)	−0.453	1	0.300	0.636	0.270	1.498
Physical task content (Pt)	1.739	1	0.009*	5.694	1.553	20.879
Effort (Ef)	−0.657	1	0.023*	0.518	0.295	0.912
Risk/Benefit (Rb)	0.191	1	0.684	1.211	0.481	3.047
Performance (Pf)	−0.225	1	0.619	0.798	0.328	1.942
Satisfaction/Dis-Satisfaction (Sd)	−0.911	1	0.072	0.402	0.149	1.084
Constant	−3.140	1	0.006	0.043		

Where: Exp is Experience, B is regression coefficient, df is degree of freedom, Sig. is significance, Exp(B) is exponent of regression coefficient.

4 Conclusion and Limitations

The results of the analysis conclude the following:

I. Workers have more chance of getting an accident than supervisors.
II. Employees with experience less than 5 years have more chance of getting an accident than other two experience groups, i.e., Exp_2 and Exp_3.

III. Comparatively aged employees, Age_3 (more than 40 years) are more prone to meet an accident than the younger, i.e., Age_1 and Age_2.
IV. Technological factors, Physical environment, Physical task content, and Effort significantly affect the chances of getting an accident by a workforce

Therefore, this study suggests that technological factors, physical environment, physical task content, and effort are the effective intervention parameters to enhance safety in underground coal mines in India. Delegating responsibility following the work compatibility of the employee will make system safer and more productive.

The data used in this study were self-reported; hence, there is a chance of bias and measurement errors. The sample size for certain groups of employees is small; hence, this might affect the results' reliability. In this study only linear model of Independent variables was used. This work can be extended by measuring the independent variable using the ratio model and an expert model.

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Muscle Fatigue Monitoring: Using HD-sEMG Techniques

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Abstract. This study used EMG coherence to investigate the correlation between muscle fatigue and beta-band energy after the dynamic biceps brachii contraction. HD-sEMG signals were acquired in experiment. 9 healthy subjects participated in the muscle contraction task (from non-fatigue to fatigue), Each participant was asked to perform two trails of experiments and exert their max-muscular strength in each trial. The result shows a significant correlation [$p = 0.0058 < 0.01$] between fatigue and energy in beta-band.

Keywords: Muscle fatigue · HD-sEMG · Fatigue analysis

1 Introduction

Due to the rapidly soaring demand for personalized fitness training, in recent years, many studies have been conducted to investigate muscle fatigue [1]. The training system using digital techniques can help the amateur, or the athlete, to visualize the training effectiveness as well as the muscle fatigue [2].

It has been reported that during muscles' repeated contraction at a near maximum strength [3], the muscle performance decline, or in other words, the muscle fatigue, can be reflected through reduced force production, speed and slower time processes of contraction and relaxation.

To reduce the risk of overtraining and injury, monitoring and evaluating muscle fatigue during (or after) exercise is crucial [2]. The maximum muscle strength can be predicted through measuring electrophysiological signals during the performance of muscle contraction. Using electrophysiological signal, such as surface electromyograms (sEMG), to visualize the muscle force and fatigue degree can increase the training efficiency and reduce the injury risk.

The sEMG signal is a non-invasive measure of the muscle physiological activities. EMG is the convolutive mixture of several motor unit action potentials (MUAPs) [3], which can represent muscle activities at both macroscopic and microscopic level. So far, the relationship between sEMG signals and muscle fatigue have not been well investigated [3]. A deeper understanding of the relation between neural control mechanism and muscle activities based on sEMG can further contribute to health monitoring, especially in the context of muscle fatigue related studies [4].

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Traditional sEMG can be employed to investigate muscle activities at macroscopic level. In contrast to traditional sEMG, high-density sEMG (HD-sEMG) technology [5] (Fig. 1) can provide high-resolution spatial activation patterns of muscle activities. This technique has been widely applied to assess the muscle function. Through sEMG decomposition based on independent component analysis (ICA), action potentials of several motor units (MUs) can be obtained, allowing fatigue assessment at the microscopic level. The principle of ICA and its application in HD-sEMG decomposition can be fetched in [6] and [7] respectively.

In this study, we investigate the relationship between muscle control and fatigue based on HD-sEMG signals. One convenient way to identify the muscle fatigue level is to observe the discharge pattern of the obtained MUs [8, 9], considering the MU discharge activities can be obtained directly through HD-sEMG decomposition.

Previous studies have reported that the coherence of MU spike trains under 60 Hz can be further divided into four different frequency sub-bands [3, 10], including delta (1–4 Hz), alpha (8–12 Hz), beta (15–30 Hz), and gamma (30–60 Hz). Each type of synchrony was reported to have different origins. The coherence of beta-brand is believed to reflect cortical and subcortical neural control information [3]. Several recent studies have shown a fatigue-induced increase in beta band coherence through sEMG signals [3, 11, 12]. Although increases of beta-brand in post fatigue have been reported, direct evidence of MUs discharges coherence has not been investigated [3].

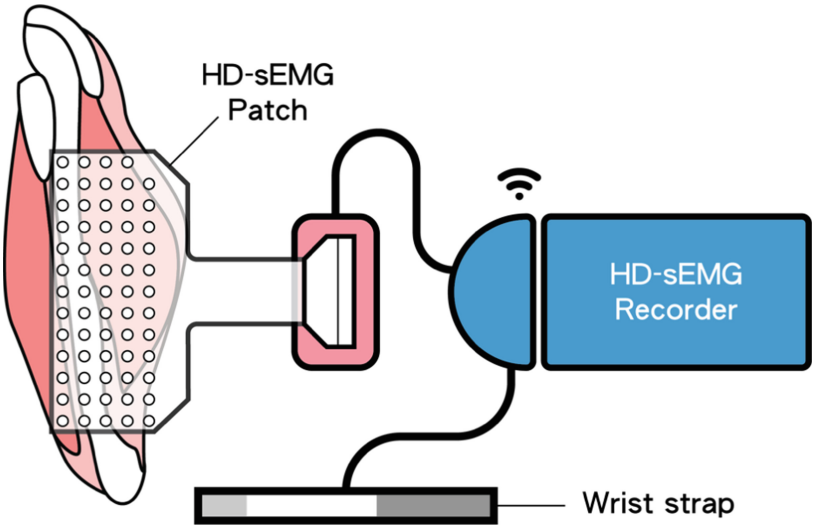

Fig. 1. HD-sEMG data acquisition equipment

2 Method

In this study, we acquired HD-sEMG signals from 9 healthy subjects (from non-fatigue to fatigue) during the continuous contraction of biceps brachii muscle (Fig. 2). Briefly, subjects preformed a series of two dynamic tasks. Each task lasted more than 60 s until task failure. Additional verbal encouragement was provided during the task. Then, subjects took a 2-min recovery interval before the next experimental trial.

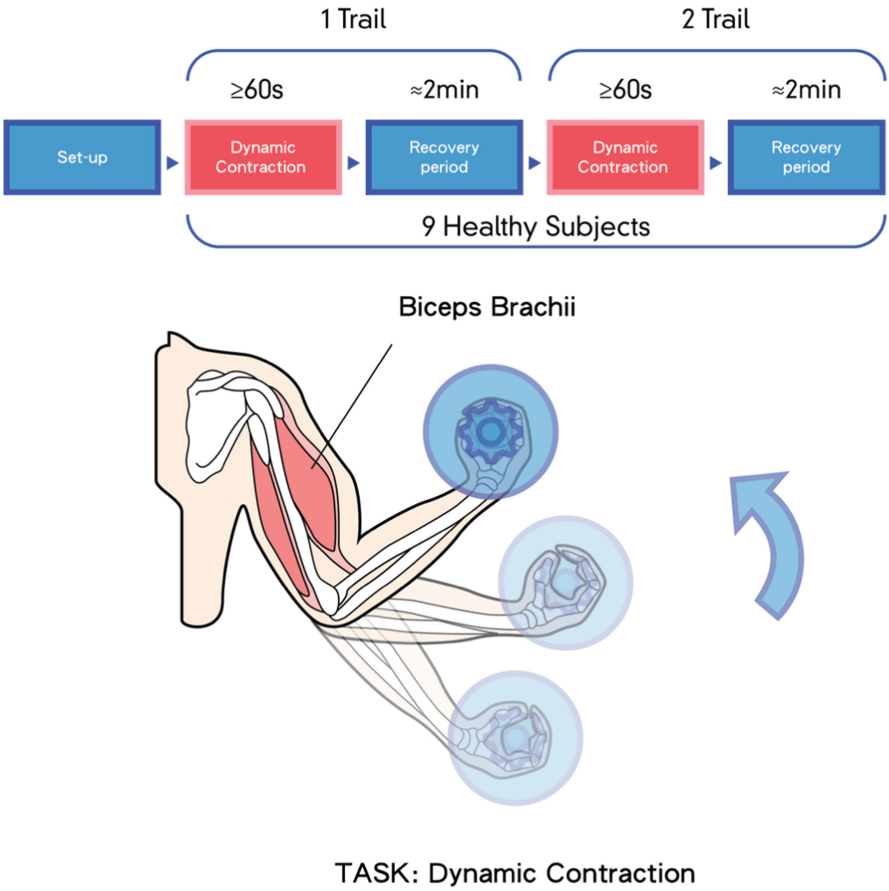

Fig. 2. Experimental procedure and dynamic contraction task

Data Analysis: The reserved sEMG recordings must satisfy the following requirements: (1) The baseline noise level is within ±10 μV and signal-to-noise ratio is greater than 5. MUAPs were extracted through the sEMG decomposition using Nawab's algorithm [13].

The amplitude of discharge coherence increased with the number of selected MU spikes [3, 10–12]. Therefore, it is recommended to use a larger number of MUs, in order to obtain better estimation. In addition, only when the same number of MU peak

sequences are analyzed can the coherence values be compared between different experiments. Since only a few acceptable MU peak sequences can be obtained in some experiments, 6 MUs were randomly selected for the coherence calculation. For trials with more than eight accepted MU, the same number of MU peak sequences were randomly selected from the accepted MU pool. A total of 6 peak sequences were randomly divided into two groups and then reduced to two composite peak sequences (CST). Multiple previous MU coherence studies employed the Welch average modified periodic graph method to calculate the size of the coherence square Cxy (f) between two CSTs:

$$C_{xy}(f) = \frac{\left|P_{xy}(f)\right|^2}{P_{xx}(f)P_{yy}(f)'}$$

where, Pxy (f) is the mean cross spectrum of two CSTs, and Pxx (f) and Pyy (f) are their respective normal spectral densities. Figure 3 shows the framework of signal processing methods. To obtain a better coherent estimation and reduce the impact of random selection, we performed 100 repeated operations and the average result was calculated to obtain the final coherence estimate of each trial.

The confidence limit for coherence estimate was:

$$\gamma_{1-\alpha}^2 = 1 - \alpha^{[1/(EDOF-1)]}$$

where α is (1 − α)% confidence level, and EDOF is the equivalent degree of freedom for Hann window.

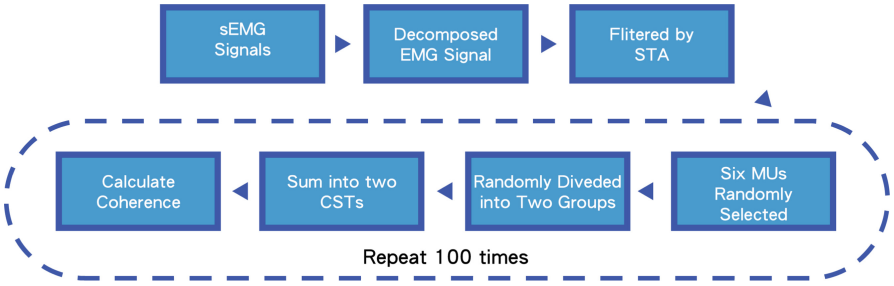

Fig. 3. Framework of signal processing methods

3 Result and Conclusion

The relationship between time (or fatigue) and average energy in beta band is shown in the Fig. 4. As aforementioned, beta-band coherence was reported as the indicator of muscle fatigue. The significant increase is displayed in the figure. With the increase of muscle fatigue degree, the energy in the beta band increases synchronously.

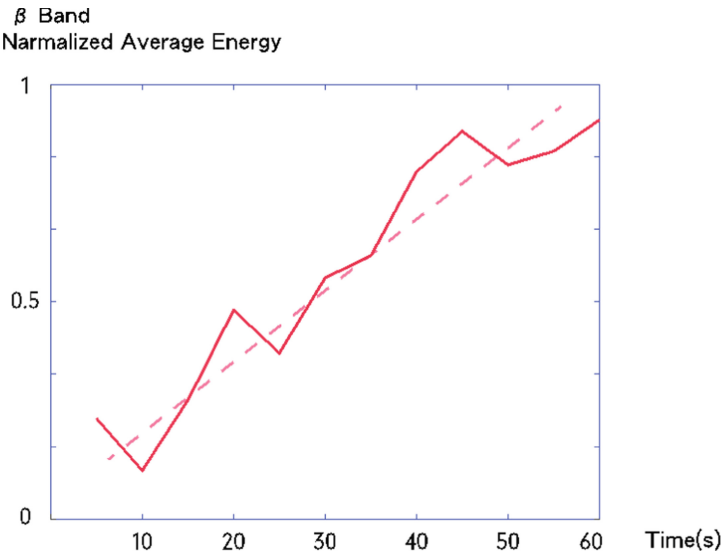

Fig. 4. Relation between time (fatigue) and beta average energy (normalized)

Table 1. Correlation between time and beta-band energy

Subject	1	2	3	4	5	6	7	8	9
Trial1	−0.4023	0.2284	0.7056	−0.2966	0.7919	0.1858	0.7485	0.6475	0.5650
Trial2	−0.1197	0.5855	−0.0327	−0.8023	0.5319	0.6976	0.7843	0.2744	0.5556

Statistic Analysis: Correlation between time (fatigue) and beta-band energy is displayed in Table 1. Data from nine subjects with two trials for each one (a total of 18 trials) were used in correlation analysis. The correlation is significantly higher than zero [$p = 0.0058 < 0.01$], indicating a significant positive correlation between beta band energy and fatigue degree.

Conclusion: A significant positive correlation was observed between time (fatigue degree) and beta-band energy. The energy increase in beta frequency bands of MU spike train coherence was observed using HD-sEMG acquired during contractions of the Biceps brachii. This result indicates that coherence in beta-band is modulated by afferent feedback in response to fatigue-induced changes within the muscle which can give a deep insight into the adaptations of the nervous system during fatigue.

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An Investigation of Chinese Driving Behavior from Driver's Perspective

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Abstract. As traffic safety has become a major health issue in China, it is crucial to characterize driving behavior and provide feasible suggestions to traffic safety works. A semi-structured interview was conducted to understand Chinese drivers' views of driving behavior and traffic safety works. The results show that the respondents have a clear understanding of safe driving behavior and believe that traffic regulations should be improved. Then, the cause of the accident experienced by respondents was divided into two categories: error and violation. Finally, the respondents provided recommendations for traffic safety work, indicating the importance of equal emphasis on hardware and software. The results of this study give useful information about driving behavior and traffic safety work in China from drivers' perspectives.

Keywords: Traffic safety · Driving behavior · Interview study

1 Introduction

Along with the economic growth, increased population and rapid urbanization, the demands for transport has increased drastically in China [1, 2]. China is the world's largest single-country automotive market since 2010 [3]. From 2005 to 2011, the average growth rate of the automotive market was 24% per year. Before 2000, cars were merely considered as luxury goods that not many Chinese families could afford; but nowadays, it is more common to purchase private cars, and a driving license is considered as a useful and popular certificate [4]. The rapid development of automotive resulted in a complicated traffic situation where two of the main issues are congestion and traffic safety [1]. In the context of the new era and the contemporary traffic background, the traffic situation in China is much more complicated than it in other countries, due to the massive number of bikes and pedestrians mixed with high-speed vehicles [5]. The differences in performance, size, and speed of various types of vehicles have a great impact on traffic capacity, safety, management and control. Therefore, China's basic research on transportation and driving is different from international studies and should develop feasible plan according to China's characteristics.

To achieve this, it is crucial to take a comprehensive overview of the traffic situation and identify safe or unsafe driving behavior where focus should be placed in order to enhance the traffic safety effectively and efficiently. However, dangerous

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behaviors don't necessarily lead to accidents, therefore, accident data in real life and simulated driving does not cover all inappropriate driving behavior. While interviews are good for getting a deep understanding of how the driver thinks. That is why interviews were chosen as method for gaining a deeper understanding of how the driver thinks and behaviors occurs in this study.

2 Method

To get a perspective of understanding aberrant driving behavior and directing future traffic safety work, several drivers with driving experience in China were interviewed about their beliefs regarding safe driving practice, accidents and important improvement areas for Chinese traffic safety. Furthermore some questions were asked about their opinions about dangerous drivers groups, dangerous driving environments and potential improvements on traffic safety.

The study population was defined as the drivers of all cars on public roads in Shanghai, China. This region contains a mixture of urban, suburban, and rural areas, and has a population of about 24.24 million people (Statistics China, 2018). Most of the interviewed drivers were driving either in urban areas or mixed driving. Only few drivers were driving mainly on the countryside.5 drivers were randomly selected on the road, and 5 interviews were performed and the participants were given an economic compensation of 150 Yuan each for participation.

The interviews were conducted in a semi-structured form with questions moved the focus from the micro perspective, i.e. the individual, to a macro perspective, i.e. a society level, which facilitates putting the results in a wider context, get a holistic view and draw conclusions about implications a future study.

3 Results and Discussion

The interview started by letting the respondents judge themselves as drivers and explain why they are safe or unsafe drivers. They also were asked about their attitudes to traffic rules. After that they made a judgement of what vehicles, driving areas and situations are more commonly involved in traffic accidents. Furthermore, they got the chance to reflect about deficiencies and potential improvements of traffic safety.

3.1 Characteristics for Safe or Unsafe Driver – Safe or Unsafe Driving Behavior

The drivers were first asked whether they consider themselves as safe drivers and thereafter what factors made them to a safe or unsafe driver. Furthermore, they were asked what they generally considered as safe and unsafe driving behavior respectively. Their opinions about a safe or unsafe driver is are summarized in Table 1.

Table 1. Opinions about a safe or unsafe driver.

Characteristics category	Safe driver – Safe driving behavior	Unsafe driver – Unsafe driving behavior
Empathy and respect	-Polite and gentle behavior -Respect for other people Follow the traffic rhythm and not impede for other drivers -Obeying the rules -Using indicator	-Lack of respect for other road users -Try to "own the road" and take shortcuts -Not paying attention to motorcycles and electric bicycles on the city roads -Casual, sudden lane changes without watching mirrors or indications
Self-control	-Focus on the driving (and don't do other things such as use phone) -Not affected by mood -Not get affected by other drivers -Be a calm and patient driver -Control the emotions and take own reasonable decision	-Impatient and aggressive driving -Easily affected by emotions -Not focusing on the driving but talking to friends or using phone

It is worth mentioning that half of the drivers were asked if they consider themselves to have good driving skills. All of the asked drivers considered themselves as having good skills. Most of them think that good driving skills are necessary to be a safe driver.

3.2 Traffic Rules

The drivers think that the Chinese traffic laws should be improved. The laws are not reasonable and there is not punishment enough for breaking them. It seems like there is no special kind of rule that was generally seen as very important or unnecessary. Someone mentioned that speed limit on the highway and areas where parking is forbidden are two good rules. Someone else mentioned general speed limits and give way signs are important while the insurance label rule is unnecessary.

3.3 Factors that Involved in Accidents

The perceptions about which vehicles are most dangerous is more similar among the interviewed drivers. Most people think that vehicles that are used for work and paid by companies are more dangerous. The drivers of these cars think that they are more skilled and they feel that they don't need to take care of the vehicles since they are rubbish and the companies pay for the maintenance. Drivers of private owned passenger cars drive more carefully since they paid for the car themselves and they take care of it more. Motorcycles and electric scooters are also considered as dangerous vehicles because the drivers of these vehicles normally ignore rules and make sudden turns.

In terms of the type of driver easily involved in accidents, most of the respondents consider young male drivers as more dangerous as men are considered as braver and

more confident in skills which make them drive in a riskier way. Some people mentioned that novices, female drivers and drivers with less education are dangerous.

In terms of the type of driving area involved in the accident, some people think highways are the most dangerous roads to drive. Others think that the urban situation can be very tricky to drive in, and cross sections are considered as dangerous by some drivers and also low speed roads without medians since people sometimes overtake cars in the opposite direction lane.

3.4 Accident Involvement and Perceived Accident Reasons

The study found that the causes of traffic accidents described by participants can be divided into two main classes of behaviors-errors and violations. Reason claims that these two classes should be treated differently in a traffic safety context, since they derive from different psychological processes.

Errors refers to the failure of planned actions to achieve intended consequences. Errors are results of cognitive processing problems [6]. Violations refers to deliberate deviations from those practices believed necessary to maintain safe operation of a potentially hazardous system. Violations include a motivational component and are influenced by the context [6]. The accidents mentioned in the interviews and types of those behaviors are shown in Table 2.

Table 2. Accidents mentioned in the interview and types of behavior.

Behavior	Example	Error	Violation
Not following traffic flow	A driver was keeping a speed that was very low which may have contributed to a dangerous situation considering the higher average speed of the other road users	◊	○
Not keeping enough distance	A driver was involved in an accident with 20-30 cars keeping to low distance to the car in front on the highway, where someone braked and all of them crashed into the rear part of the car in front	○	○
Breaking turning rules	A driver was going straight ahead where he was supposed to turn left while the other drivers turned right where you were not allowed	◊	○
Missing traffic lights	A driver mentioned that he had missed a traffic light when he was a novice driver. He was overtaking a truck and the weather was rainy and he did a traffic violation to cross red light	○	◊
Carelessly changing lanes	A driver failed to look in the mirror while doing a lane change when he was a novice driver	○	◊
Speeding	A driver experienced an accident by driving too fast while turning left in an urban road and didn't notice a pedestrian who was crossing the road	○	◊

Note: "○" means that the behavior belongs to this category, "◊" means that the behavior does not belong to this category.

3.5 Future Traffic Safety Work

When asking the drivers about what they think should be changed to improve the traffic safety there were a great amount of opinions about improvements. The results are collected into four categories that can be found below.

Infrastructure and Traffic Management. From a traffic management perspective there is a need for improvement of infrastructure such as roads and traffic lights in order to ensure the traffic flow and also visibility. But one of the biggest problems is that there are too many cars. One driver compared driving in China with driving in America. There are many cars on the roads both in China and America but the driver felt much safer while driving in America since the drivers were much more organized, followed the traffic flow.

Education. Both improved driving education and general education would improve the traffic safety. The driving school should teach the drivers more practical knowledge and practice on real roads instead of just practice for passing the driver's examination. The drivers should learn why they should keep a better distance to the car in front and about the consequences of dangerous behavior.

Active Safety Systems. Different ADAS have different acceptance in China. One of the respondents thought that the car should detect and inform about things that differ from the normal traffic situation. It should also give hints and guide the driver in a way that is adapted to the local driving conditions.

Culture. There are some skilled drivers who only care about their own cars. There is a lack of attention and care about other people. With better education and influences from other countries the situation will be better. The aggression level among all the drivers needs to be reduced.

4 Conclusions

This interview study investigated Chinese driving behavior and found out what behaviors are characteristic for Chinese drivers as well what behaviors are dangerous and How to improve driving safety by improving behavior. The driver in the interview indicated that A safe driver should have good control of the car. Correspondingly, unsafe drivers tend to be aggressive and distracted, and lack the respect for other road users. The respondent also believes the traffic laws should be improved as the Current laws are not reasonable and there is not punishment enough for breaking them. In addition, this study presented and distinguished the accident causes in the traffic accidents stated by the respondent. Finally, effective suggestion on traffic safety work were provided, showing the importance of equal emphasis on the construction of hardware-transportation system facilities, and the construction of software-driving education and law enforcement.

The analysis in this paper give useful information about what behaviors should be reduced in order to improve traffic safety in China as well as indications on how to improve the behavior. It also explains which aspects of construction, in terms of infrastructure and active safety systems, to focus on during traffic interventions.

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Properties of Emulsion Sausage with Partial Replacement of Fat by Dragon Fruit Peel Powder

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Abstract. This study aimed to investigate the effect of various levels of dragon fruit peel powder (DFPP) on the physical, chemical and sensory properties of emulsion sausage. DFPP was prepared from drying with a tray dryer at 55 °C for 6 h and ground into powder. DFPP had contents of moisture, protein, fat, ash, crude fiber and carbohydrate as following order respectively: 15.52, 1.79, 0.48, 13.28, 7.88, and 61.05. Water holding capacity, oil holding capacity, and swelling capacity of DFPP were 13.71 g water/g sample, 2.67 g oil/g sample, and 15.94 ml/g, respectively. Emulsion sausages were produced by replacement of pork fat with five different levels of DFPP (0.5, 1.0, 1.5, 2.0, and 2.5%). It was found that moisture, ash and crude fiber contents of sausage increased when the amount of DFPP increased. Sausages made of the addition of 2.0 and 2.5% DFPP had the lowest crude fat content. Adding DFPP resulted in expressible moisture and lower L* (lightness) than the control without DFPP. However, the result of this adding caused higher a* (redness), b* (yellowness), and cooking yield. High DFPP content increased hardness, springiness, gumminess, and chewiness but it decreased cohesiveness. Sausage with 2.0% DFPP had no significant difference of sensory score in appearance, flavor, texture, and overall acceptability. Therefore, the addition of DFPP is useful in improving the qualities, nutritional values, and sensory acceptability of sausage.

Keywords: Dragon fruit peel · Emulsion sausage · Physical properties · Chemical properties · Sensory properties

1 Introduction

Dragon fruit or pitaya is a native tropical of Central and South America. It is also widely cultivated in Southeast Asia such as Malaysia, Thailand, and Vietnam [1]. Dragon fruit peel is discarded as a waste from fruit juice production that usually used as fertilizer. There are three species of dragon fruits i.e. *Hylocereus polyrhizus* (red peel, red-purple pulp), *Hylocereus megalanthus* (yellow peel, white pulp), and *Hylocereus undatus* (red peel, white pulp) [2]. Dragon fruit peel has very high dietary fiber (69.30%), pectin (10.8%), and betacyanin (150.46 mg/100 g) [3]. A previous study reported that dragon fruit peels of *H. undatus* and *H. polyrhizus* contained higher

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phenolic content and radical scavenging activities than the pulps. Moreover, the phenolic content in peels of *H. undatus* was higher than *H. polyrhizus* [4]. Emulsified meat products i.e. sausages, they consist of high fat content (15–33%) [5]. High consumption of fat especially saturated fat associated with health problems e.g. diabetes, heart disease, high blood pressure and several types of cancer [6]. Fat in emulsion meat products plays an important role in emulsion stability, improve cooking and sensory qualities [7]. Therefore, fat reduction affects physical, sensory and cooking properties of emulsion sausages. The aim of this study was to determine the effect of various levels of DFPP on the properties of partial reduced fat emulsion sausage.

1.1 Preparation of Dragon Fruit Peel Powder

Dragon fruit (*Hylocereus undatus*) was purchased from a local market in Bangkok, Thailand. The fresh peel was separated manually and cut into small pieces. Then, ground with a blender and dried in a hot air oven at 55 °C for 6 h. Dried dragon fruit peel was ground into powder and sieved through a 60-mesh screen. The dragon fruit peel powder (DFPP) was kept and sealed in a plastic bag at −20 °C for further investigation.

1.2 Preparation of Emulsion Sausage

Fresh pork meat and pork back fat were purchased from a local market in Bangkok, Thailand. All fat and connective tissue (epimysium) were removed from muscles and ground through a 2 mm plate grinder. The control sausage was prepared with pork meat (46.75%), pork back fat (24.88%), crushed ice (24.88%), seasoning (1.62%), sodium chloride (1.10%), soy protein with isolated powder (0.47%), sodium tripolyphosphate (0.20%), sodium erythorbate (0.09%), and sodium nitrite (0.01%). Other sausages were partially replaced pork back fat with different amounts of DFPP (0.5, 1.0, 1.5, 2.0, and 2.5%). The DFPP was prepared by blending with water. Then, DFPP solution was frozen by a freezer at −30 °C. Next, ground pork meat was adding to the chopper and mixed with salt, additives, and half amount of ice (frozen DFPP solution). After chopping for 5 min, the ground pork back fat, seasoning, and the rest of the ice were added and chopped for 10 min. Meat batter was stuffed into collagen casings with 22 mm diameter and 15 cm length. Sausages were dried and smoked at 70 °C for 30 min and boiled at 75 °C for 30 min. After cooking, the sausages were immediately cooled at 10 °C. The samples were vacuum-packed in plastic bags and stored in the refrigerator at 4 ± 2 °C.

1.3 Analytical Methods

The chemical compositions (moisture, fat, ash, crude fiber, protein, and carbohydrate contents) of DFPP and emulsion sausages were determined according to the method described by AOAC [8]. Water activity (a_w) of DFPP was determined by using a thermoconstanter (Novasina TH 200, Switzerland) at 25 °C. Colors of DFFP and emulsion sausages were determined by using a spectrophotometer (Hunter Lab, Color Quest XE, USA) equipped with a light source illuminant D65 and 10° for observation.

CIELAB system; L* a*, and b* values were measured. Water holding capacity (WHC) together with oil holding capacity (OHC) and swelling capacity (SWC) were determined according to [9] and [1] with slight modification. The texture profile analysis parameters were determined by using a texture analyser (Lloyd Instrument, TA plus, UK) equipped with a 50 N load cell and a cylinder probe (5 cm diameter). Samples were comprised of 50% of original height at test speed of 50 mm/min. The cylinder sausages approximately 2 cm in diameter and 2.5 cm in height. The parameters were obtained hardness (N), cohesiveness, springiness (mm), gumminess (N), chewiness (N.mm). Cooking yield and expressible moisture or juiciness was modified according to the methods of [10]. The sensory evaluation of sausages was conducted by 30 untrained panellists. Appearance, colour, odor, flavor, texture and overall acceptability sensory attributes were evaluated using a 9-point Hedonic scale. All experiments and analytical measurements were done in triplicate. All data were processed by using the analysis of variance (ANOVA). The level of statistical significance is $p \leq 0.05$.

2 Results and Discussion

2.1 Chemical and Physical Properties of Dragon Fruit Peel Powder

The chemical compositions and physical properties of DFPP are presented in Table 1. The composition of DFPF includes 15.52% moisture content, 1.79% protein content, 0.48% fat content, 13.28% ash content, 7.87% crude fiber content, and 61.05% carbohydrate content. DFPP had low water activity (0.60). DFPP has color of dark-red. WHC, OHC, and swelling capacity of DFPP were 13.71 g water/g sample, 2.67 g oil/g sample, and 15.94 ml/g, respectively.

Table 1. Chemical composition and physical properties of dragon fruit peel powder

Parameters	
Moisture (%)	15.52 ± 015
Protein (%)	1.79 ± 0.06
Fat (%)	0.48 ± 0.04
Ash (%)	13.28 ± 0.03
Crude fiber (%)	7.87 ± 0.42
Carbohydrate (%)	61.05 ± 0.86
Water activity (a_w)	0.60 ± 0.01
L*	41.87 ± 1.29
a*	18.29 ± 1.24
b*	7.15 ± 1.24
Water holding capacity (g water/g sample)	13.71 ± 1.75
Oil holding capacity (g oil/g sample)	2.67 ± 0.22
Swelling capacity (ml/g)	15.94 ± 1.26

2.2 Chemical Composition of Emulsion Sausages

The chemical composition of the emulsion sausages with various concentrations of DFPP are shown in Table 2. The moisture content of sausages with 2.0 and 2.5% DFPP were higher than the sausage with 0, 0.5, 1.0 and 1.5% ($p \leq 0.05$). This might occur because of the high water holding capacity of DFPP. The Fat and protein contents decreased when DFPP concentrations increased. Sausages with 2 and 2.5% DFPP had lower level of fat and protein contents than 0, 0.5, and 1.0% DFPP. The ash and crude fiber contents of sausage were the highest in 2.5% DFPP sample, which due to the presence of mineral and fiber in DFPP. The carbohydrate contents of sausages with 1.5, 2.0, and 2.5% with DFPP were higher than others because of DFPP had high carbohydrate content.

Table 2. Chemical composition of emulsion sausage

Chemical composition	Dragon fruit peel powder level (%)					
	0	0.5	1.0	1.5	2.0	2.5
Moisture	61.15 ± 0.08^{b}	60.52 ± 0.75^{b}	61.05 ± 0.30^{b}	61.81 ± 0.22^{b}	63.25 ± 0.70^{a}	63.45 ± 0.65^{a}
Fat	21.58 ± 0.78^{a}	20.26 ± 0.83^{a}	20.45 ± 1.76^{a}	19.74 ± 1.41^{ab}	16.78 ± 0.91^{b}	17.11 ± 1.19^{b}
Protein	14.12 ± 0.82^{a}	12.51 ± 2.57^{ab}	11.68 ± 0.19^{ab}	11.20 ± 0.38^{ab}	10.93 ± 0.59^{b}	10.66 ± 0.22^{b}
Ash	2.81 ± 0.02^{d}	3.34 ± 0.02^{c}	3.37 ± 0.05^{c}	3.52 ± 0.04^{b}	3.54 ± 0.03^{ab}	3.61 ± 0.02^{a}
Crude fiber	0.23 ± 0.03^{e}	0.48 ± 0.05^{d}	0.57 ± 0.04^{d}	0.79 ± 0.03^{c}	0.95 ± 0.00^{b}	1.12 ± 0.11^{a}
Carbohydrate	0.13 ± 1.50^{d}	2.71 ± 2.56^{c}	3.36 ± 1.82^{b}	3.64 ± 1.82^{a}	3.73 ± 0.04^{a}	3.84 ± 1.21^{a}

Mean in the same row with different letters are significantly different ($p \leq 0.05$)

2.3 Physical Properties of Emulsion Sausages

The lightness (L*), redness (a*), and yellowness (b*) of sausages with different concentrations of DFPP are shown in Table 3. The lightness values of sausages decreased by increasing DFPP ($p \leq 0.05$). On the other hand, the redness and yellowness of values increased when DFPP increased ($p \leq 0.05$). Therefore, the lightness, redness, and yellowness of sausages were affected by the color of DFPP. Sausage with 2.5% DFPP had the lowest lightness and highest level of redness and yellowness.

Table 3. Color of emulsion sausage

Color parameters	Dragon fruit peel powder level (%)					
	0	0.5	1.0	1.5	2.0	2.5
L*	60.29 ± 1.28^{a}	59.43 ± 0.25^{a}	59.32 ± 0.48^{a}	58.94 ± 1.86^{ab}	57.13 ± 1.40^{bc}	55.91 ± 0.49^{c}
a*	10.50 ± 0.48^{c}	11.06 ± 0.19^{c}	12.36 ± 0.51^{c}	13.25 ± 0.57^{b}	13.36 ± 0.34^{b}	14.28 ± 0.70^{a}
b*	$15.82 \pm o.92^{d}$	19.26 ± 0.67^{c}	19.69 ± 0.99^{bc}	19.75 ± 1.19^{bc}	20.99 ± 0.43^{ab}	21.70 ± 0.97^{a}

Mean in the same row with different letters are significantly different ($p \leq 0.05$)

Texture profile analysis and cooking properties of emulsion sausage are shown in Table 4. The presence of DFPP significantly affected the texture properties of emulsion sausages ($p \leq 0.05$). The hardness, springiness, gumminess, and chewiness increased when DFPP increased but the cohesiveness decreased. The sausage with 2.5% DFPP

had the highest in hardness. The sausages with 2.0, and 2.5% DFPP had higher springiness, gumminess, and chewiness than the control. Cooking yield and expressible moisture are indicators of cooking resistance of sausage. High cooking yield and low expressible moisture are preferable. The results show that the increasing of DFPP was responsible for increased cooking yield and decreased expressible moisture.

Table 4. Texture profile analysis and cooking properties of emulsion sausage

Parameters	Dragon fruit peel powder level (%)					
	0	0.5	1.0	1.5	2.0	2.5
Hardness (N)	15.25 ± 1.89^{d}	21.30 ± 2.22^{c}	24.69 ± 4.13^{bc}	24.40 ± 2.35^{bc}	26.20 ± 1.09^{b}	31.36 ± 1.06^{a}
Cohesiveness	0.49 ± 0.02^{a}	0.49 ± 0.22^{a}	0.49 ± 0.02^{a}	0.48 ± 0.02^{a}	0.40 ± 0.13^{b}	0.41 ± 0.01^{b}
Springiness (mm)	6.29 ± 0.17^{b}	6.61 ± 0.05^{b}	6.66 ± 0.05^{b}	6.57 ± 0.15^{b}	8.43 ± 0.16^{a}	8.84 ± 0.97^{a}
Gumminess (N)	0.76 ± 0.86^{d}	1.07 ± 0.86^{c}	1.24 ± 0.17^{abc}	1.20 ± 0.06^{bc}	1.31 ± 0.21^{ab}	1.44 ± 0.07^{a}
Chewiness (N.mm)	4.81 ± 0.63^{c}	7.04 ± 0.58^{b}	8.23 ± 1.11^{b}	7.86 ± 0.28^{b}	12.81 ± 0.26^{a}	14.02 ± 1.01^{a}
Cooking yield (%)	72.81 ± 0.75^{c}	77.20 ± 0.83^{b}	78.39 ± 0.33^{ab}	79.52 ± 0.45^{a}	80.43 ± 0.56^{a}	80.81 ± 0.48^{a}
Expressible moisture (%)	0.55 ± 0.16^{a}	0.39 ± 0.03^{b}	0.35 ± 0.04^{b}	0.33 ± 0.03^{b}	0.28 ± 0.01^{b}	0.25 ± 0.05^{b}

Mean in the same row with different letters are significantly different ($p \leq 0.05$)

2.4 Sensory Evaluation

Table 5 presents the sensory attributes of emulsion sausage that were compared for appearance, color, odor, flavor, taste, and overall acceptability. Addition of DFPP at various levels had no significantly different in flavor, and texture score. Furthermore, emulsion sausage with added DFPP at the level 2.0% was not significantly different compare to the control sample for appearance, and overall acceptability. Therefore, in this study, sausage added with 2.0% DFPP is suggested to produce to improve nutrition of this product.

Table 5. Sensory evaluation of emulsion sausage

Texture parameters	Dragon fruit peel powder level (%)					
	0	0.5	1.0	1.5	2.0	2.5
Appearance	6.33 ± 1.75^{ab}	7.00 ± 1.36^{ab}	7.13 ± 1.40^{a}	6.90 ± 1.47^{ab}	6.87 ± 1.07^{ab}	6.23 ± 1.48^{b}
Color	6.27 ± 1.89^{b}	7.40 ± 1.00^{a}	7.20 ± 1.32^{a}	7.27 ± 1.39^{a}	7.23 ± 1.10^{a}	6.87 ± 1.41^{ab}
Odor	5.70 ± 1.68^{b}	6.13 ± 1.57^{ab}	6.40 ± 1.61^{ab}	6.73 ± 1.31^{a}	6.70 ± 1.26^{a}	6.13 ± 1.57^{ab}
Flavor^{ns}	6.30 ± 2.04	6.63 ± 1.65	6.77 ± 1.77	6.93 ± 1.39	6.73 ± 1.39	6.37 ± 1.63
Texture^{ns}	6.40 ± 1.57	7.00 ± 1.26	7.20 ± 1.30	7.23 ± 1.14	6.90 ± 0.88	6.20 ± 1.16
Overall acceptability	6.40 ± 1.57^{bc}	7.00 ± 1.26^{ab}	7.20 ± 1.30^{a}	7.23 ± 1.14^{a}	6.90 ± 0.88^{ab}	6.20 ± 1.17^{c}

Mean in the same row with different letters are significantly different ($p \leq 0.05$)
^{ns} = no significant difference ($p > 0.05$)

3 Conclusion

In conclusion, the addition of DFPP as a partial replacement of fat in emulsion sausages had a significant effect on the properties including chemical, physical, and sensory properties. The incorporation of DFPP in emulsion sausages resulted in lower fat and protein contents but higher moisture, ash, crude fiber, and carbohydrate contents than the control sausage. Sausages with DFPP had lower in lightness but higher in redness and yellowness. The addition of DFPP increased all texture parameters except cohesiveness. DFPP has a good water holding capacity and increased DFPP in sausages resulted in increased cooking yield and reduced expressible moisture. The sensory score of sausage with 2.0% DFPP had no difference from the control in appearance, flavor, texture, and overall acceptability.

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Rapid Imaging of Latent Fingerprints Using Xanthone Compounds on Silica Nanoparticles Detected by UV Spectrophotometry

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Abstract. Xanthone is the phytochemical which is extracted from the Garcinia mangostana. Xanthone components have yellow color and absorption in the wavelength in 254 and 366 nm and detected by the ultraviolet spectrophotometer. Garcinia mangostana is the plant growth in the east and south of Thailand, peel of the fruit has many xanthone. Extracted of the peel with water: ethanol (1:1) gave xanthone components, and have yellow color when stained on the paper or skin cannot remove it with water. The experiments used the extracted of xanthone components developing on the Silica Nanoparticles (SNP-X). The xanthone covered on the porous of Silica Nanoparticles which have binding affinity on the latent fingerprints (LFPs) detection. The simple preparation and easy controls of the surface properties of SNP-X showed the potential on the UV absorption labeling compounds for enhanced the latent fingerprint detection in forensic science for individual identification.

Keywords: Fingerprint · Garcinia mangostana · Phytochemical · Silica Nanoparticle · Xanthone

1 Introduction

Fingerprints have the powerful utilized of the human physical property, which is providing the special information of the gender, presence of human metabolites. Fingerprints showed the evidences in the scene of crime due to its usage for personal identification based on the fact, which is different of ridge patterns [1]. Latent fingerprints (LFPs) are not view with the naked eye because of their poor optical contrast. Therefore, physical and chemical treatment of LFPs were needed to enable their detection.

Reported, LFPs were detected with ninhydrin solution and iodine/benzoflavone spray [2, 3]. Thereafter, various methods, such as tetraphenylethene-base dye [4], organic dye [5] and detected by fluorescence have been developed for detecting and visualizing LFPs [6]. Among these methods, powder dusting has been widely used as an extremely simple and effective method for LFPs detection on diverse surfaces by fluorescent [7] and luminescent employing metallic [8, 9]. The application methods of fluorescent nanomaterials are used several chemicals, it is still subject to several limitations such as

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difficulty of application on some surfaces, low contrast, low selectivity, background interference and toxicity [10]. The silica nanoparticles were developed for containing organic dyes and amorphous silica have been proposed. Silicon is in the environment in different forms and found combination with oxygen or hydroxides are 78% in the crystalline compounds for example quartz, flint, opal, silacates, found in oceans as silicic acid and also is found in living organisms like sponges, grasses, algae. Synthesis of the silica nanoparticles with the Stober process by hydrolysis of alkyl silicates and condensation of silicic acid in alcohol solution using ammonium hydroxide as catalyst (11). The size of silica particles increases with the volume of Tetraethyl orthosilicate (TEOS) and ammonia concentration. The hydrolysis reaction are forming by hydroxyl group of water substituted ethoxy groups of TEOS and ammonia works as a basic catalyst. The rate of hydrolysis effected by the concentrate of TEOS and water. Colloids of hydroxyl group of intermediate [Si(OC2H5)4-X(OH)x] were in solution. The reaction of organosilicon compounds in acid-base as follows:

$$2 \equiv \text{Si-OH} + (CH_3)_3\text{-Si-NH-Si}(CH_3)_3 \rightarrow 2 \equiv \text{Si-O-Si-NH-Si-}(CH_3)_3 \rightarrow 2 \equiv \text{Si-O-Si}\,(CH_3)_3 + NH_3 \quad (1)$$

The study attended to using phytochemical dye from the fruits of Gacinia mangostana which have many xanthones and have yellow colors [12]. G.mangostana is Guttiferae family and is in a tropical evergreen tree and has edible fruit which known as the purple mangosteen. It growth in the south and the west of south of Thailand and have produce in the August to October which has many peels were the waste. The phytochemical of peel mangosteen were contained significantly higher contents of phenolics and tannins and xanthones [13]. Xanthones and their derivatives are known in alpha-mangostana beta-mangostin and gramma-mangostin showed in Fig. 1 [14]. Phytochemical studies of G.mamgostana had revealed that the xanthones exhibited a variety of bioactivities such as antioxidant antibacterial antifungal anti-inflammatory and cytotoxic activities [15]. The study were detect by Ultraviolet-visible (UV-visible) spectrophotometry in the wavelength of 256 and 366 nm. The silica nanoparticles absorbed xanthone compounds. Therefore, the study planned that preparation of xanthoe silica nanoparticles (SNP-X) and using for latent fingerprints and detected by UV-spectrophotometer (Fig. 2).

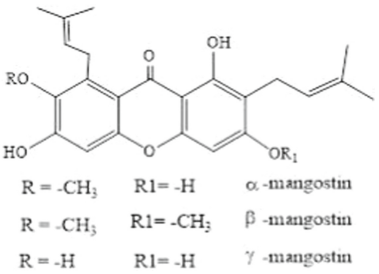

Fig. 1. Structure of α, β and γ-mangostin

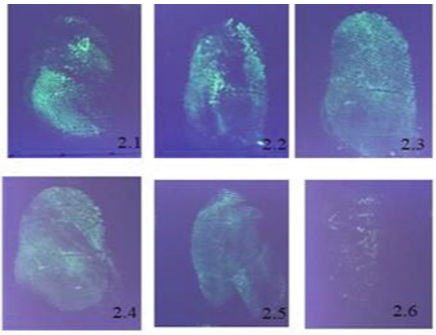

Fig. 2. Images of latent fingerprints under UV 366 nm show details in concentration of the xanthone components in 1, 0.5, 0.25, 0.125, 0.0625 and 0.032 mg/ml, developed in SNPX in Fig. 2.1–2.6, respectively.

2 Materials and Methods

2.1 Materials

Silica Nanoparticles. The materials required for the synthesis of silica nanoparticles were described as follows: Tetraethyl orthosilicate (TEOS 98%) was obtained from the Fischer Sciencetific, Ammonium hydroxide solution 31.5% (NH3) was used as received from the QLEC chemical Co.Ltd., Absolute ethanol 99% from EMSURE® ACS Merck solvents Company. The 50 nm silica nanoparticles were prepared by Stober method [12]. Tetraethyl orthosilicate (TEOS) (3 ml) was added to the mixture of deionized water (12 ml), ethanol (74 ml) and ammonia (3 ml). The mixture was stirred for 24 h at 35 °C, them 50 nm silica nanoparticles were washed with excess deionized water 3 times. Thereafter the colloidal solution was separated by high-speed centrifuge, and the silica particles were washed by ethanol for three times to remove undesirable particles. Followed by drying in oven at 100 ^{o}C for 2 h to prevent continuous reaction.

Plants Material. Fruits of Mangosteens (*G. mangostana Linn*.) were collected in the local market in Bangkok, Thailand. The rind was 3 kg and dried for 3 days in the hot air oven at 50 °C and macerated in ethanol. The crude ethanol extracted were frationationed by separatory funnel with water and chloroform (300:500 ml). The crude chloroform dried by rotary evaporator.

2.2 General Experimental Procedures

About 100 mg of crude extracted of chloroform diluted in concentrations of 1, 0.5, 0.25, 0.125, 0.0625 and 0.03225 mg/ml in ethanol solvent. The λmax at 370 nm were set for standard curve by UV spectrophotometer.

2.3 Preparation of Crude Extracted Xanthones Modified on Silica Nanoparticles

The silica colloids of 50 nm diameter (10 mg) were pretreated with the crude chloroform extracted in concentration 1 mg/1 ml mixed them and dried in the hot dried oven by 2 h. Repeated for prepared the xanthones silica nanoparticles in concentrations of 0.5, 0.25, 0.125, 0.0625 and 0.03225 mg/ml. The mixed of xanthones on the silica Nanoparticles (SNP-X) dried for 2 h in the hot air oven at 50 °C and grind them. The samples of LFPs collected on the glass were stained with SNP-X and sprayed with Natural produets-polyethylenglyeol *reagent* (*NP*/*PEG*); (1% methanolic diphenylboric acid-ß-ethylamino ester (diphenylboryloxyethylamine) (*NP*), followed by 5% ethanolic polyethyleneglycol-4000 (*PEG*). LFPs were clearly under UV spectrometry at 366 nm. The cruded xanthones were absorbed in the porous of LFPs which were examined by the Infrared spectrophotometer were Perkin Elmer, KBr. The SNP-X in concentrations of 1, 0.5, 0.25, 0.125, 0.0625 and 0.03225 mg/ml in were recovery by ethanol extracted and calculated percentage of the silica nanoparticles absorbed the cruded xanthones by UV spectrophotometer.

2.4 Scanning Light Microscope Analysis (SLM)

SLM analyses of silica nanoparticles were carried out using Olympus co.th. on silica particles to investigate the diameter of silica particles. To prepare samples for SLM analysis, silica powder is dispersed in absolute ethanol and a drop of silica colloid solution on the slide glass and cover with cover slide and magnified to 200× and photograph by digital camera.

3 Results and Discussion

3.1 Preparation of Crude Extracted Xanthons Components from *G.Mangostana Extraction Crude Xanthone Components*

The rind fruit of *G.mangostana* (3000 g) extracted with ethanol: water (1:1; 2 L: 2L) gave cruded were 489 g. Purification the cruded ethanol and water extracted by partition with glass funnel and used solvent of chloroform: water (1:1; 1:1L) gave the dried cruded chloroform are 183 g and calculated were 6.1%. Cerebration curve of crude xanthones components and percentage of the absorption of silica nanoparticles. The cruded of chloroform of *G. mangostana* prepared in concentrations of 1, 0.5, 0.25, 0.125, 0.0625 and 0.03225 mg/ml by ethanol. The λmax at 370 nm were set for standard curve by UV spectrophotometer. Cerebration curve are importance for examine the absorption the crude xanthone components of silica nanoparticles. Table 1 showed the percentage of silica nanoparticles absorbed the cruded xanthone.

Table 1. Percentage of the absorption of cruded xanthones of SNPs per 10 mg.

Standard cruded xanthones (mg/ml)		Recovery of SNP-X	Concentration recovery	Absorption of SNPs	% Absorption of SNPs
Conc.	UV absorbance data λmax 370 nm	UV absorbance recovery	Linear equation y = 2.335x + 0.874		
1	2.817	0.8451	0.4708	0.5292	52.9
0.5	2.594	0.7263	0.3520	0.1480	14.8
0.25	1.947	0.4868	0.1124	0.1376	14.0
0.125	1.391	0.1391	−0.2352	0.3602	36.0
0.0625	0.796	0.0598	−0.3145	0.3770	37.0
0.03225	0.297	0.0224	−0.3519	0.3841	38.0

The absorption xanthone components of SNPs in 1 mg/ml were 52.9%, is the best absorption in Table 1. Figure 2 showed SNP-X in 1 mg/ml stained on the samples of LFPs was not clear and some SNP-X coagulate, 1 mg/ml of cruded xanthone is much more over the SNPs absorption. Therefore, the samples of LFPs collected on the glass were stained with SNP-X in concentration 0.25 mg/ml is suitable for absorption in SNPs and sprayed with NP/PEG found that in SNP-X in concentration 0.25 mg/ml showed the best clearing.

These detailed features identified in the fingerprint form the basis of personal identification. Furthermore, xanthone components has been also used in wide range of application for silica nanoparticle exhibited nontoxicity, biocompatibility and are excellent chemical stability. Therefore, we suggest that the SNPX has great potential as regards use as ultraviolet labeling maker for fingerprint detection.

3.2 Synthesis of 50 nm Silica Nanoparticles and Absorbed of Cruded Xanthone

Silica nanoparticles were synthesized by using TEOS, deionized water, ethanol and ammonia and were stirred for 24 h at 35 °C. The colloidal solution was separated by high-speed centrifuge, and drying in oven at 100 ^{o}C for 2 h gave 438 mg of 50 nm silica nanoparticles. Figure 3 showed that the prepared silica particles are spherical and there is no wide distribution in the particles sizes the ammonia catalysis effect. The nanoparticles are increased of the condensation (Fig. 3b) and SNPs absorbed the cruded xanthone of *G.mamgostana* (Fig. 3c).

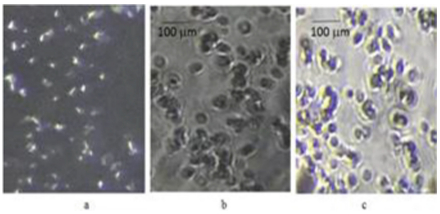

Fig. 3. Synthesis of silica nanoparticles (a) 50 nm of SNPs under scanning light microscope 100× (b) 50 nm of SNPs under scanning light microscope 200× and (c) 50 nm of SNPs and absorbed the cruded xanthone components under scanning light microscope 200×.

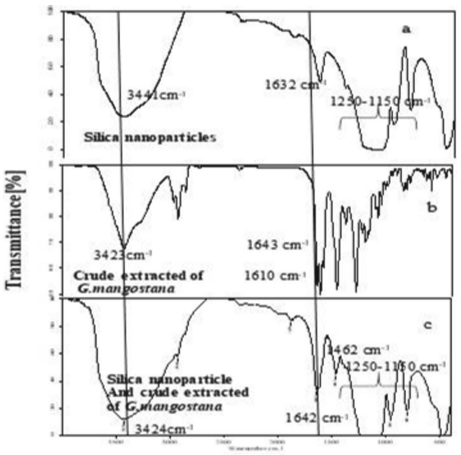

Fig. 4. FT-IR graphs of (a) SNPs; (b) the cruded xanthone extracted of peel of G. mangostana and (c) SNPs absorbed the cruded xanthone components.

IR spectroscopy determined the potential functional groups that are responsible for proving the absorbtion the xanthones components of SNPs. Figure 3a shows the spectra obtained from 50 nm SNPs, Fig. 3b showed the spectra obtained xanthones component from *G.mangostana* peel extract and Fig. 3c SNP-X synthesized using cruded xanthones of the *G.mangostana* peels extract. SNPs were synthesized by Stober method and showed the major stretching appearing at 3000–3700 cm^{-1} indicates the presence of O-H stretching which signifies the presence of hydroxyl of SNPs in structure. Figure 3b stretching appearing at 3000–3500 cm^{-1} indicates the presence of O-H stretching in structure of xanthone. Aside the O-H stretching, at the region of 2963 cm − 1 and 2925 cm^{-1} the presence of C-H bond in xanthone while at the region of 1642, 1610 cm $^{-1}$ it shows the presence of C=O stretching, C-C aromatics stretch is observed for both spectra at the region of 1500–1460 cm^{-1} which is relevant to the aromatic. Finally, C-O-C stretch can be found in the range of 1281, 1223, 1198, 1077, 1050, 1010 cm^{-1} [17]. Spectra shifting occurs from 953-801 cm^{-1} to after capping with SNP-X (Fig. 4).

4 Conclusions

Xanthones components are easy for detecting and are absorbed the UV in the λ366 nm. This study synthesized the 50 μm silica nanoparticles and absorbed the xanthones components for examined the latent of fingerprints for nontoxic reagents. The usage of peels from fruits of *G. mangostana* takes full advantage of unwanted waste material which is economically friendly, efficient, and safe. Even though this method is effective for the development of LFPs under some prevalent conditions, it is still subject to several limitations such as difficulty of application on some surfaces, low contrast, low selectivity and high background interference. Further, the study is developing the method for solving the aforementioned problem.

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Competing Interests. The authors declare that they do not have conflict of interest.

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The Assessment of Environment Impact Quotient Field Use Rating from the Rate of Pesticides in Padd in Bang Rachan District, Sing Buri Province

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Abstract. In Thailand, rice farmers rely on pesticides to control a variety of pests. The study aims to survey of pesticide use in paddy and to assess of EIQ (Environment Impact Quotient) Field Use Rating from the rate of pesticides in paddy, Bang Rachan District, Sing Buri province. The sample consisted of 161 households that were selected by using stratified sampling and proportional sampling. The data were calculated with Calculator for EIQ Field Use Rating to assess of EIQ Field Use Rating (EIQ-FUR). The results showed that 29 types of active ingredients of pesticides, Pho Chon Kai subdistrict, Bang Rachan district had a low EIQ-FUR (37.32). Most of the sample villages (63.6%) had a low EIQ-FUR, while the EIQ-FUR was very low with 27.3% and a moderate level of 9.10%, and founded that the use of pesticides will have the greatest impact on the ecosystem, followed by consumers and famers respectively.

Keywords: EIQ · EIQ-FUR · Pesticide · Paddy

1 Introduction

In the past decades, Thai agriculture tends to rely more on pesticides. According to the statistics of the Bureau of Agricultural Economics, 2018, reported the value of imports of agricultural pesticides in the type of chemicals in 2017 found that the value of imports is more than 27,922 million baht, although agricultural chemicals are useful for controlling To the epidemic of diseases and pests to a certain extent But it is also toxic by itself. Coupled with the incorrect use of chemicals by farmers And excessive use Including the use without strict policies and legal measures Therefore causing problems to the health of farmers and consumers An environmental problem occurred Including being a factor that causes economic loss in both the short and long term.

Rice is still an important economic crop for Thai exports. Throughout the past years, Thai rice has been continuously developing varieties and quality. It is well accepted by consumers around the world that it is a good quality rice. Making Thai rice to be in demand in both domestic and foreign markets Thai farmers are using more

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chemicals in rice fields to accelerate the growth of rice plants. With the use of substances that inhibit the growth of weeds that cover the rice plants until damage And the use of various pesticides that are quick and easy with For this reason, there is a chemical residue in the products and products of rice. Which affects health issues for both rice farmers and rice consumers affect the economy Including environmental. which leads to unsustainable agriculture. The implementation of agricultural sustainability requires an integrated management of water management, such as using rainfall-runoff modeling through Artificial Neural Network [1]. Soil management, such as reduce chemical fertilizer and pesticides. The study of environmental problems resulting from the use of agricultural chemicals is one of the important issues that will lead to agricultural sustainability.

Evaluation of the hazards posed by pesticides to the environment and human health is complex, involving many factors such as: application conditions, slope and altitude of the plot, local soil characteristics, weather patterns, and pesticide properties. In an effort to summarize this complexity more than 100 tools have been developed in different countries for the evaluation of secondary adverse effects of pesticides [2]. One of the more wildly used measures is the Environmental Impact Quotient (EIQ) [3], which is a composite environmental impact assessment system that developed by Kovach et al. (1992). The EIQ is regarded as relatively easy to use and has been frequently presented in the scientific literature as a useful means to estimate potential environmental hazards associated with agricultural pesticide use [4–9]. Furthermore, the EIQ approach permits the integration into one value of several important environmental and human health impacts that could be reduced through greater use of IPM technologies and practices.

Thus, we see the importance of such issues. Therefore assessing the environmental impact at the farm level from the rate of pesticide use in paddy to make rice farmers aware of the dangers of pesticide use And reduce the use of pesticides In order to lead the agriculture that is environmentally friendly.

2 Research Objectives

2.1 To survey of pesticide use in paddy of Bang Rachan District, Sing Buri province.
2.2 To assess of EIQ (Environment Impact Quotient) Field Use Rating from the rate of pesticides in paddy, Bang Rachan District, Sing Buri province.

3 Methodology

One subdistricts from Bang Rachan District, Sing Buri province was selected for the study: Pho Chon Kai Subdistrict. (see Fig. 1). This area was selected because of their importance in Sing Buri rice production.

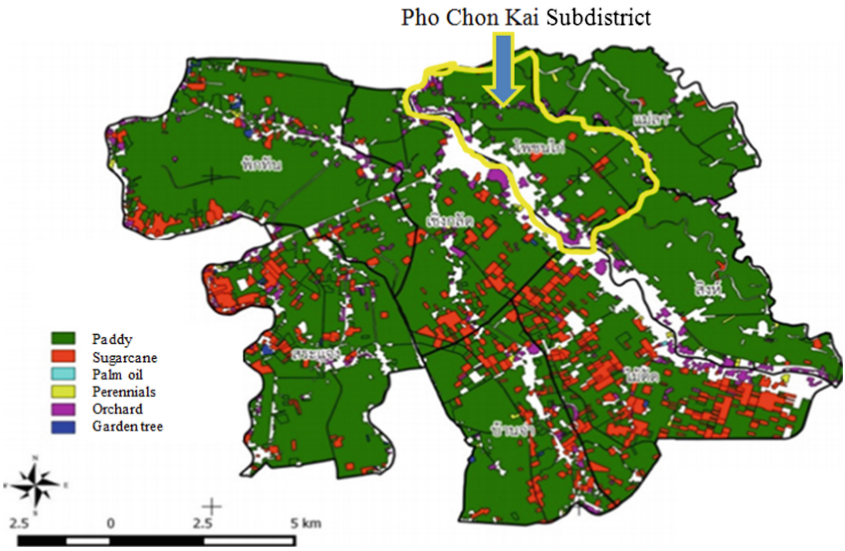

Fig. 1. Location of the surveyed district for the study in Bang Rachan District, Sing Buri province.

3.1 Tool

This is a survey research, in which the study is conducted through collecting data from semi-structured interviews. The size of the sample group is determine with the formula of Yamane. A total of 162 farmers by proportional sampling from 11 village were surveyed between January and March of 2019 to gather information about rice production during their most recent crop cycle, including detail questions on pesticide use.

3.2 Analysis

Data related to pesticides (insecticides, herbicides and fungicides) used in paddy were gathered through face to face filling semi-structured interviews. The indices measured in this study include Environmental Impact Quotient (EIQ) and its components (farm worker, consumer, leaching and ecology) and Field Use Rating- EIQ (FUR-EIQ). EIQ is calculated based on the work of Kovach et al. (1992) [3]. The formula is:

$$EIQ = \{C[(DT \times 5) + (DT \times P)] + [(C \times ((S + P)/2) \times SY) + (L)] + [(F \times R) + (D \times ((S + P)/2) \times 3) + (Z \times P \times 3) + (B \times P \times 5)]\}/3 \quad (1)$$

In this formula:

DT: Dermal Toxicity
C: long term health effects;
SY: mode of action
F: fish toxicity
L: leaching potential
R: surface runoff potential
D: bird toxicity
S: soil residue half-life
Z: bee toxicity
B: beneficial arthropod toxicity
P: plant surface half-life.

EIQ field use rating (EIQ-FUR) was calculated by multiplying the EIQ value for a specific chemical from the table by the percent active ingredient in the formulation and the rate of its dosage used per hectare [3]:

$$\text{EIQ} - \text{FUR} \;=\; \text{EIQ} \;\times\; \% \text{ active ingredient} \times \text{Rate} \qquad (2)$$

Using the Field Use EIQ Calculator from https://nysipm.cornell.edu/eiq/calculator-field-use-eiq/ Calculator for Field Use EIQ (Environmental Impact Quotient) [10]. The lower the EIQ-FUR, the lower the environmental impact [11]. The following can be used as a guide for Classify environmental impacts, [11].

<25	very low	<50	low		
50-100	moderate	>100	high	>150	very high

4 Result

4.1 The Use of Pesticides in Paddy of Bang Rachan District, Sing Buri Province

Most of farmers had the period of using pesticides more than 10 years, accounting for 60.9%, followed by the period of using chemicals between 5–10 years, representing 30.4%, followed by the period of using chemicals between 1–5 years, representing 8.7%. When considering the active ingredients used in the area, it was found two fungicide active ingredients, fifteen herbicide active ingredients and twelve insecticide active ingredients were having been used to control pest and diseases in the most recent rice crop cycle (see Tables 1, 2 and 3).

Table 1. Active ingredients and doses (l/100 m.sq or kg/100 m.sq) of fungicides used in Bang Rachan District.

Active ingredients	Doses/100 m.sq
Triazole	1.25
Inorganic + Alkylenebis	1.88

Table 2. Active ingredients and doses (l/100 m.sq or kg/100 m.sq) of herbicides used in Bang Rachan District.

Active ingredients	Doses/100 m.sq	Active ingredients	Doses/100 m.sq
Isoxazolidinone + anilide	18.23	Anilide	62.5
Chloroacetamide	14.37	Sulionyfurea	5.0
Glycine derivative	25.78	Phosphinic acid	62.5
Phenoxycarboxylic acid	14.17	Antibiotic	1.87
Bipyridylium	25.0	Phenylamide	2.5
Cyclohexanedione oxime	5.63	Pyrimidinyloxybenzoic	6.25
Triazole	1.25	Pyrazosulfuron-ethyl	12.5
Anilide + Thiocarbamate	25.0		

Table 3. Active ingredients and doses (l/100 m.sq or kg/100 m.sq) of insecticides used in Bang Rachan District.

Active ingredients	Doses/100 m.sq	Active ingredients	Doses/100 m.sq
Organophosphante	2.7	Organophosphate	1.88
Chlorpyrifos	2.5	Diamide+ Neonicotinoid	0.25
Pyrethroid	7.5	Thiadiazin	0.63
Organophosphante + Pyrethroid	2.0	Carbamate	1.88
Phenylpyrazole	0.33	Avermectin	1.25
Neonicotinoid	0.52	Thiadiazole	12.5

4.2 EIQ Field Use Rating (EIQ-FUR) in Paddy, Bang Rachan District, Sing Buri Province

Pho Chon Kai Subdistrict, Bang Rachan District had a low EIQ-FUR (37.32). When considering the Field Use EIQ Components, farmers consumers and ecosystems, it founded that the use of pesticides will have the greatest impact on the ecosystem.

Most of the sample villages (63.6%) had a low EIQ-FUR, while the EIQ-FUR was very low with 27.3% and a moderate level of 9.10%. The lower the EIQ-FUR, the lower the environmental impact. show in the Table 4.

Table 4. EIQ-FUR for paddy in 11 villages of Pho Chon Kai Subdistrict, Bang Rachan District.

Village	Field use EIQ components			EIQ-FUR	Level of impact
	Farm worker	Consumer	Ecological		
1	6.7	17.2	49.1	24.4	Very low
2	7.4	20.4	57.9	28.6	Low
3	7.6	22.7	66.1	32.6	Low
4	7.9	17.0	67.5	30.9	Low
5	5.9	20.5	50.4	26.0	Low
6	8.2	22.9	75.8	36.6	Low
7	6.0	13.5	49.2	23.4	Very low
8	10.3	88.5	118.6	55.1	Moderate
9	5.7	13.0	53.4	24.4	Very low
10	8.5	25.4	70.4	37.4	Low
11	9.9	26.7	82.6	40.2	Low
Subdistrict	8.34	28.54	73.49	37.32	Low

5 Conclusion and Discussion

From the study, In the area of Bang Rachan District, Sing Buri province Most of farmers had the period of using pesticides more than 10 years. Two fungicide active ingredients, fifteen herbicide active ingredients and twelve insecticide active ingredients were having

been used to in paddy. EIQ Field Use Rating (EIQ-FUR) in paddy, Bang Rachan District, Sing Buri province. This area had a low EIQ-FUR. We can say that the use of pesticides in this area has a low level of environmental impact. However, the use of pesticides must be carefully.

According to the study, organizations related to agricultural promotion should study in villages with low EIQ-FUR about that using pesticides, agricultural system and economics for develop a model of farming that is environmentally friendly.

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Smart Textile for Architecture: Living with Technology

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Abstract. In architecture, the fixed elements that help people to circulate in spaces need to change often. Signs and Information are everywhere. If a new technology with sensors could be introduced into architecture, adding new functions and helping constant changing, this action could probably be a new sustainable measure for our future. Adding to a textile all the needed information can, on the one hand, be observed or, on the other hand, produce sounds and images that improve quality of life.

In public buildings, hospitals or social buildings, where interventions need to be fast and active, a new world can embed technology in architecture to meet sustainable open solutions and goals. The internal application on buildings may be the beginning for a real future connection into textile and the 'Figure of the Architect.' The benefits will be in a direction of new and more sustainable and green places.

Keywords: Smart textile · Architecture · Smart Buildings · Green buildings · Climate smart cities

1 Introduction

Signals are everywhere and serve as guiding objects for our vision and brain orientation. The technology we find today has not yet adapted to the sensory power of the human being.

"*Current technology supports only special-purpose, low-volume textiles, garments, and electronics. Moreover, the textile, electronics, and software industries have different product cycles, cultures, and pricing models, creating scores of practical problems for smart textiles… We envision incorporating generic, unstructured sensing layers into the fabric as it's being produced. The simplest example of such a layer is a conductive coating applied to the entire surface. Another example is 2D grids of conductive threads woven into the fabric*." [1]

The information can reach the human being today is a problem with so much information circulating in the database called the internet. The information that can reach the user has to be worked out and adapted to the needs, space and the body. All of these choices are transforming and are part of a continuous and current study.

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Several approaches are being used in scientific research for the development of electrically conductive textiles as part of the area of smart textiles. Currently, only a few commercial smart textiles based on the use of conductive polymers are present, although a large number of laboratory-scale structures can be found. It has been found that it is becoming increasingly necessary to look for new forms of development, while the question of the washability of these textiles needs to be taken into account in various marketed applications. Therefore, a good research strategy and industry plan play the most important role aftermarket needs and new technologies.

2 New Body Actions

When we talk about human beings, we talk about reactions and bodily actions. Any look, movement, or action can trigger endless results, depending on person to person. A long analysis made focused on the well-being of a human person "…*investigated the physical activity patterns of people affected by depressive and anxiety disorders as measured by accelerometer. Their study revealed that both depressive and anxiety disorders can be relieved by exercise, and emphasized the importance to investigate the patterns of physical activity of the mildly to moderately affected sufferers to estimate the treatment potential.*" [2]

This study on the results concerns the design and creation of networked smart textiles, combined with wireless capability, soft switches, and accelerometers, developed by a group of psychotherapists, textile designers, and computer scientists to identifying how textiles can benefit people's mental wellbeing resulted in "…*Voice recorded data was gathered from users who were holding/interacting with a smart textile whilst walking. The data was transcribed into textual information and thereafter analyzed to evaluate the level of anxiety of participants. A semantic analysis revealed significant differences in the vocabulary the 'anxious' and 'not so anxious' participants utilized to express themselves during the walks. We demonstrate that voice recorded data can help understand the patterns detected in accelerometer data collected from the smart textiles, using the data of one participant. When introducing new technology such as the smart textiles, which will impact on the psychology of users, it is important to capture information about the emotions and thoughts of users about the technology, perhaps even in the form of a textual review or a diary provided by the user after using the technology*." [2]

3 Applications

Nowadays, technical solutions are inside a vast universe of technology that the difficulty lies in creating boundaries at the research. "…*The interaction of the tactile sensor into a textile is a promising strategy to address the requirements of lightweight, flexibility…challenges by designing helically swollen architecture in core-sheath fibers for tactile sensing textiles (TSTs)…show bending-independence pressure perception and special acuity*" [3].

"*TST has demonstrated by plain weaving novel sensing fibers with core-sheath structure. The sensing fiber and TST exhibited bending-independent pressure perception and special acuity in real-time…*" [3]

The cutting-edge fibers turn doormats and other fabrics into smart textiles. Like tablecloths that can switch off Wi-Fi.

The use of conductive fibers with sensory functionalities in the weaving process is what turns normal fabrics into smart textiles. These intelligent fabrics can be imbued with any number of features, such as the ability to sense changes in pressure or tension, transform their shape and color, or respond to electrostatic change.

But what is this technology good for?

In the field of telecommunications, smart fabrics can open the door to interesting scenarios such as:

- tablecloths that switch off Wi-Fi to make evening meals a smartphone- and laptop-free experience,
- doormats that can sense when someone enters or leaves the house and switch the Wi-Fi on or off accordingly,
- or wall hangings that measure Wi-Fi quality and display any faults.

Many of these ideas are either still in their infancy or merely thought experiments. For example, making the fabrics washable is just one hurdle still to be overcome. But even the prototypes are opening up our eyes to the huge range of possibilities these smart textiles have to offer.

4 Opportunities and Applications

An introductory group of new solutions into Smart Buildings can be integrated into what we can a new Future Architects' responsibility that it is a new attitude nowadays. All of the new solutions will be part of an integrant part of benefits to buildings and Urban Spaces worldwide. Graphic Communication can be changed and integrated into the paradigm of sustainability worldwide. Most architects touch only a fraction of new buildings, and that green buildings are a thing. I also understand resistance from clients can torpedo Big Ideas. None of that gets us off the hook. Architects are the construction community's leaders; builders take their cues from us. A good architect is persuasive, and the greatest among us can sell anything to anyone. Admit it: Over the last 50 years, we've had the power to move the built environment from carbon positive to carbon net-zero. We didn't, though, and the result of our failure is disappearing Arctic ice, global rainforests afire, and a melting Antarctica. Building a carbon-zero/carbon-negative society within the next 30 years will take a World War II–scale mobilization vision that's simply not on the horizon. All new materials, solutions, actions can make a difference. Smart textiles can reduce and improve the architect's attitude and use of knowledge.

The simplest example of such a layer is a conductive coating applied to the entire surface. Another example is 2D grids of conductive threads woven into the fabric. More complex designs, such as two grids of conductive lines (woven or printed),

separated by an insulating layer (that is, a potential array of resistive pressure sensors) are also possible." [4]

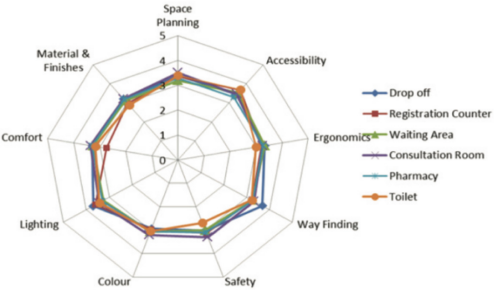
Other levels of research can introduce the quality of health and direct benefits for human life. The research focused on the development of a cotton smart textile with medical properties using lime oil microcapsules introduced a "*develop an antioxidant and antibacterial active smart cotton fabric using encapsulated lime oil (LO).*" Under the research, they conclude that "*The SEM images confirmed the steady attachment of LO microcapsules to the cotton fibers. The cotton fabric containing LO microcapsules displayed significant antibacterial activity against four bacterial species before and after subjecting the fabric to wash conditions*". [5] As a result, research similar to this can introduce into rooms in a house with a new level of antibacterial and antioxidant systems that can help a person during sleep time for example.

Many past researches have used Post Occupancy Evaluation (POE) technique to assess performance of occupied buildings especially health projects, that is an example of the investigation from Carthey (2006) and from Preiser (2009) [6].

Table 1. Overall scoring for survey items

		Healthcare Facilities						
		Drop off	Registration Counter	Waiting Area	Consultation Room	Pharmacy	Toilet	Overall mean
Design Aspect	Space Planning	3.39	3.36	3.20	3.50	3.29	3.4	3.4
	Accessibility	3.44	3.65	3.52	3.45	3.29	3.68	3.4
	Ergonomics	3.33	3.21	3.33	3.24	3.27	2.99	3.2
	Way Finding	3.69	3.24	3.25	3.32	3.26	3.22	3.3
	Safety	3.02	3.12	3.00	3.3	3.1	2.69	3.0
	Colour	2.93	2.96	3.06	3.21	3.06	3.04	3.0
	Lighting	3.7	3.60	3.27	3.45	3.30	3.43	3.5
	Comfort	3.29	2.74	3.27	3.35	3.31	3.17	3.2
	Material & Finishes	3.19	2.98	3.11	3.2	3.16	2.87	3.1
	Overall mean	3.3	3.2	3.2	3.3	3.2	3.2	3.2

Notes: Rating scale, 1= Worst, 2= Bad, 3= Neutral, 4= Good, 5= Best. Scoring below neutral (<3) are highlighted in bold.



Following the research made by Samah [6] where is possible to see at the Table 1 that has an analysis of 401 patients answered to this survey that was conducted in the month of January and February 2011. Respondents comprise a good mix of the three ethnic groups in Malaysia - Malay, Chinese, and Indian. It is possible to see at the Table 1 that the results indicate that a majority of the answers "…*rated the design aspects of each area within the neutral range with an average rating between 3.17 and 3.23. None of the spaces received 'good' and above rating (above 4). In terms of comfort, the registration counter area scored the lowest (2.74) and the consultation rooms scored highest (3.35). On the overall, the registration area and toilet area were scored lowest whereby 3 out of the 9 design aspects were rated below neutral. Relatively waiting area, consultation room and pharmacy areas received better scoring as they received above neutral scoring for all design aspects. Highest rating was lighting (3.5), followed by space planning (3.4), accessibility (3.4) and way finding (3.3). Ergonomic (3.2), comfort (3.2), safety (3.0), finishes & materials (3.1) and color (3.0) were rated fair. Based on this result, it can be concluded that patients and visitors find the overall performance of the facility to be acceptable but fair in meeting their satisfaction needs."* [6]

Following the results of this survey, we realized that the hospital space is seen as a place of need for permanence and not space where people feel comfortable to overcome so many physical and psychological difficulties. It is the architect's function to prepare the space with requirements that respond far beyond basic needs in order to produce a better quality of being for the user (Fig. 1).

Fig. 1. Khoo Teck Puat Hospital in Singapore. A waterfall in the central garden courtyard.

5 Conclusions

The research used a post-occupancy evaluation technique as the method to determine the performance of a built facility based on users' satisfaction and experiences can be one of the first tools to analyse spaces. The walkthrough observational technique provided a closer investigation to reveal micro aspects of interior design that could be further improved to serve the patients and other users better. Future research can be more detailed when the architect decides to focus on each compartment, proposing new colours, new lights, new sounds and even bringing nature inside of the hospital with a system that tricks the human brain.

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Management, Training and Business Applications

Identifying High Performance Indicators (HPI) for Close Combat Forces in a Military Training Environment

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Abstract. As the military continues its transition from counter-insurgency to one of multi-domain operations (MDO) and the possibility of facing a near-peer threat, the need to achieve overmatch becomes even more important. The Army must be able to attract, retain, and maximize the potential of high quality Soldiers capable of conducting MDO. Optimizing human performance provides an area to achieve overmatch on a large scale through improving Soldier performance in training and on the battlefield. In an effort to gain a more comprehensive understanding of what aspects of human performance correlate to success in military training and on the battlefield, personnel from the Maneuver Center of Excellence (MCoE) and multiple other Department of Defense (DoD) and Army organizations partnered to create a study team and conduct a comprehensive, multi-disciplinary study of indicators of high performance for close combat forces.

Keywords: High performance indicators · Optimizing human performance

As the military continues its transition from counter-insurgency to one of multi-domain operations (MDO) and the possibility of facing a near-peer threat, the need to achieve overmatch becomes even more important. In order to achieve overmatch, the Army must be able to attract, retain, and maximize the potential of high quality Soldiers capable of conducting MDO1 [1]. The optimization of human performance provides an area to achieve overmatch on a large scale through improving Soldier performance in training and on the battlefield. Due to its complexity, the human system continues to be one of the most studied, yet more difficult, systems to understand and to predict performance outcomes. In an effort to gain a more comprehensive understanding of what aspects of human performance correlate to success in military training and on the battlefield, personnel from the Maneuver Center of Excellence (MCoE) and multiple other Department of Defense (DoD) and Army organizations partnered to create a study team and conduct a comprehensive, multi-disciplinary study of indicators of high performance for close combat forces.

Army training centers continually update and revise initial entry training (IET) programs to enhance the knowledge, skills, abilities, and attributes of their trainees to provide capable Soldiers to the operational force. Additionally, these programs have

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worked to identify latent medical conditions and to reduce attrition resulting from injury and failure to adapt to military service. Training programs focus their instruction on critical military occupational specialty (MOS) skills, physical fitness, and other performance-oriented training to produce an operationally competent Soldier. Predictably, the result is a normal distribution of trainee performance for each task that describes a small number of trainees who are highly successful adapting to, performing to, and exceeding training standards; a small number of trainees who are unsuccessful at meeting training standards; and a majority who meet the standards, but do not demonstrate a high level of proficiency. Importantly, force manning requirements influence these programs to bulk select and prepare the maximum number of trainees to first meet minimum performance standards, often while neglecting performance optimization for individual Soldiers. However, as previously noted, there is an increased need for training programs to optimize and enhance individual Soldier performance in the field to achieve overmatch against near-peer adversaries. This imperative implies a greater need for research to quantify the simultaneous interplay of multiple cognitive, behavioral, and physiological systems and how they work together to support performance. Also implied, is a need for a nuanced model for military performance that promotes individualized training schemes so that each Soldier can receive data-informed guidance to reach their potential. To achieve this, the present study recommends three activities: (1) conduct concurrent research of multiple psychological and physiological facets of military-specific performance in field-relevant environments, (2) model the complexities that promote, and ultimately develop, individuals who exhibit the highest levels of performance during military operations, and (3) establish data-driven feedback loops between high-performance models and Soldier training programs.

In order to capture the factors that contribute to high performance, the study focuses on a subset of trainees from Infantry One Station Unit Training (IN OSUT- U.S. Army IET for Infantrymen) that choose to pursue a place in United States Army Special Operations Forces (SOF). These trainees attend IN OSUT and subsequently attend a specialty selection program to enter their respective units. The trainees selected from these two cohorts represent some of the highest caliber new Soldiers in Army close combat forces and present an opportunity to gain an enhanced understanding of high performing individuals undertaking a difficult career path.

Through a comprehensive approach to better understand military, field-based human performance, the study team will assess, evaluate, and analyze the physical, psychological, and physiological aspects of the trainees' performance prior to, during, and immediately following IN OSUT and during their follow-on specialty selection program. The research design also will adopt an unbiased approach in studying and analyzing the data in that no one set of variables is more predictive of human performance over others. The goal is to measure the variables of human performance as holistically as possible and let the data reveal the capabilities and attributes that have the greatest correlation with high performance. Upon identifying those attributes, or indicators, the training program leadership can revise its content, methodology, progression, or demand to further cultivate the attributes identified in the model.

Thus, the study employs a longitudinal research design to determine the strongest predictors of performance for completion of the follow-on specialty selection programs.

The study will include approximately 3,000 Army trainees who have volunteered during the recruitment phase of the accessions process to pursue a career as a special operator. As such, the participants who are included in the study consent to participate at the beginning of the project and respond to a pre-OSUT assessment battery of cognitive (e.g., working memory, creative thinking, systems thinking) and non-cognitive measures (e.g., personality and motivational attribute measures), demographic and background items, and reports of prior injuries. During the middle of IN OSUT, the participants will respond to a short questionnaire consisting of items reflecting confidence in performing Soldier tasks, motivational attributes, and injuries incurred while in IN OSUT. At the conclusion of IN OSUT, the participants will complete a post-OSUT assessment battery of non-cognitive measures and injuries incurred in the latter half of IN OSUT. Additionally, the participants will complete a peer evaluation measure at the beginning and end of IN OSUT which asks them to rate each member of their squad (approximately a 9-person unit) on the Army Special Operations Forces (ARSOF) attributes and designate the top and bottom three performers of their platoon (approximately a 30-person unit).

Concurrent with the above psychological measurements, biological collections will occur at the beginning and end of multiple IN OSUT cycles in the study. Initially, these collections will include serological samples for high-resolution determination of factors associated with discrete medical and nutritional complications that can lead to injury. These collections will include metabolomics analyses for both blood and saliva; the latter being collected again at the beginning and end of other classes over the following twelve months. Metabolomics is the systems-level study of multiple physiological processes and their concurrent relative activity levels. This will be conducted in order to infer the impact of multiple physiological systems, as they adapt over the course of military training, on the ultimate success of the individual in follow-on specialty selection programs. Importantly, many of these physiological processes are affected by psychological factors, like with stress on arousal systems [2] and immune system activation [3]. Additionally, physiological systems can impact the psychology of the individual [4], such as with glucose availability [5] and hormone levels [6] on mood and cognition [7]. By taking a systems approach, these psycho-physiological relationships and how they adapt over time can be ascertained and included in the performance prediction model.

Following IN OSUT, the participants' performance on leader and Soldier tasks during follow-on specialty selection programs will be assessed with both cadre/instructor and peer ratings. Additionally, exit interviews will be conducted with the Soldiers to obtain a better understanding from their perspective on their performance during these rigorous selection phases.

The desired outcome and principal deliverable for the HPI study is a predictive performance model for close combat forces with recommendations for interventions to improve selection, training, and retention among trainees. As such, the quantitative data will be managed and analyzed to ensure that both the measurement and structural models are reliable and valid. Moreover, machine learning will be employed to determine the strongest predictors of performance in the two specialty selection programs. The results will allow for a determination of a final model consisting of both the latent variables and their associated measurement indicators that contribute to the best fitting

model of performance. The findings also will be used to create profiles of the cognitive, non-cognitive, and background measures that are predictive of successful performance in the follow-on selection programs. Specifically, using a configural approach, participants can be assigned to different profiles depending on whether they possesses high or low levels of the attributes (c.f., Sinclair, Tucker, Cullen and Wright [8]). Soldiers can then receive feedback on how to increase their ability to demonstrate higher levels of the attributes that are malleable.

The desired predictive model will not be a "silver bullet" in the form of a prescriptive method for cultivating high performance–nor will the model be used to as a discriminator to "select-out" recruits for close combat forces who do not fall within the range of the model. The intent is to model the indicators that predict high performance that can help training programs target the most relevant and salient aspects of an individual trainee's performance profile. Additionally, a superior enumeration and understanding of the human facets of military performance can have a corresponding impact on the programs designed to optimize them. Training programs would be better able to test and select developmental events, training methodologies, nutrition interventions, and educational milestones for their effectiveness in enhancing their overall training impact.

Enhanced understanding of successful performance indicators has the potential to significantly benefit the operational force, special training populations, and the accessions process. Operational units will benefit from an expanded population of more proficient graduates; special training populations can reduce their attrition rate during follow-on assessment and selection programs; and Army accessions personnel can begin to identify, recruit, and sign potential trainees to combat arms military occupational specialties (MOSs) with increased confidence in their ability to complete training. In support of these imperatives, many Army research organizations are studying the various aspects of human performance and how they relate to specific and discrete categories of military performance. Those efforts are vital and should continue to inform Army recruiting, training, and performance-enhancement programs. However, there is a distinct need for synergy between these research and performance programs. To meet this need, the present study intends to deliver a comprehensive and holistic model of high performance indicators that allows for the integration of laboratory research findings with IET and other military training programs.

The information this study and its model provide will be the basis for instituting training interventions into the OSUT program. Selected interventions will be focused on developing those indicators that most highly correlate with success from the study population in an effort to improve the entirety of future training populations. Historically, the military is very proficient at introducing new training strategies and methodologies to improve the results of psychomotor-based training requirements, however the less-tangible and psychological demands of Army training, as well as the physiological components, continue to be difficult to develop. With a greater understanding of the mental and physiological attributes that correlate with high performance, training program leadership can develop new and innovative strategies to cultivate them. For example, grit or mental toughness is an often-cited attribute military leaders look for in close combat Soldiers. However, developing mental toughness is a challenging and difficult task. With the comprehensive set of data from the study, other

related factors (ex: ambiguity tolerance, perseverance, etc.) may be able to provide course training developers the ability to modify training methodology to enhance those attributes. Trainees may need to be exposed to common military training situations where there is not a clear answer and work through the problem to successfully complete the exercise. Other examples may include trainees conducting highly rigorous physical tasks with no published standard or time limit; or designing task-based exercises that include programmed failure to observe a trainee's ability to overcome setbacks. From a physiological standpoint, a change in dietary intake and overall nutritional education could be introduced to enhance trainee performance. Regardless of the interventions introduced to the training program, the study data will be the driving factor in determining what attributes need to be developed in order to achieve a greater level of high performing graduates from the program.

Ultimately, this study and its model is intended to help individual trainees, with their trainers, target their unique training needs as they strive for excellence in military operations and assist the Army in building and sustaining multi-domain formation through the selection, training and education of its Soldiers and leaders [9]. In this way, we hope to start shifting the focus from bulk efforts to meet minimum standards of performance to more individualized programs for Soldier performance optimization in the field.

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Digitalization of the Last Mile of a Humanitarian Supply Chain

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Abstract. The digitalization of humanitarian supply chains allows overcoming one of the greatest difficulties faced by NGOs and governments in managing health equipment in crisis situations: the visibility of stocks and consumption at the end of the chain. This paper presents the design process of the health equipment inventory management system developed to support the humanitarian crisis related to the Syrian refugees in Lebanon. The prototype was tested at the pharmacy of the ICRC Weapon-wounded Trauma and Training Centre in Tripoli, Lebanon, where it was demonstrated to be easy to use and able to facilitate the work related to the management of medicament stocks and orders.

Keywords: Supply chain · Humanitarian aid · Medicaments · Digitalization

1 Introduction

For NGOs and public health service providers, the management of equipment, medicines and food distribution are crucial issues. In particular, this need is highly necessary in areas where the concentration of refugees is very high and/or the infrastructure does not allow for timely control and regular delivery. It is essential to be able to manage drug stocks and food distribution efficiently and continuously. The most crucial part of planning remains the visibility of stocks and consumption of health

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clinics with which NGOs collaborate to distribute equipment [1]. This becomes even more important in cases of spread of contagious diseases or in crisis situations. The Syrian civil war has created conditions conducive to the spread in refugee camps of normally controlled diseases such as tuberculosis, polio or measles [2]. For migrant populations in Jordan, logistical coordination of health services has become a priority in response to health disaster [3]. The current priority is to improve the drug distribution chain in isolated permanent care centers [4].

The digitalization of the supply chains promises to improve many aspects related to logistics enabling real-time full-transparency and decentralized, autonomous management [5]. The rest of this paper presents the design process for the development of a system able to support the tracking and tracing of medicaments in last segment of humanitarian supply chains.

2 Related Work

The distribution of humanitarian aid is often treated as a series of discrete activities that are decoupled from each other, with a weak link between the different stages of this process and, indeed, the development of a continuous supply chain has never been a priority [6]. Unfortunately, this lack of harmonization and continuity has resulted in significant waste of resources, in some cases up to 30% of total resources [6]. An efficient supply chain is fundamental in crisis situations because the distribution of humanitarian aid must be carried out in the short term and under conditions of great stress. Although research in supply chain optimization and formalization is rather advanced in commercial applications, it is unfortunately not possible to directly transfer these processes for business logistics to the distribution of humanitarian aid [6]. In addition, these types of crises that require a rapid response in terms of aid distribution are constantly increasing. In particular, in the case of population movements caused by the explosion of conflicts, not only does the displacement of all these people require a huge logistical effort, but the distribution of food, water, medicines and shelter are also critical activities for the well-being of these people. NGOs often play a key role in these situations, especially in the field. Most of their work is done impeccably; however, their systems and approaches are often obsolete [7]. A valuable support for effective logistics management comes from technology as it allows immediate dissemination of information, rapid reporting and even helps learning [8]. Unfortunately, there are no systems in place to control stock and consumption at the end of the chain, when health centers are in isolated areas without a high-speed network [9]. Indeed, there is a shortage of investment in the development of appropriate technologies for logistics management and supply chain management for humanitarian aid, probably due to the constant need for NGOs to deal with rather limited budgets [7]. On the other hand, the adoption of such systems could optimize supply chain and logistics management processes, allowing NGOs to save money by reducing waste and obtaining a rather advantageous return on investment [7]. Today, NGOs have the choice either to buy commercial systems already developed that do not allow adaptation to their requirements, or to develop small customized internal solutions that do not allow scale-up [8].

3 Design

The development of the system to digitalize the last segment of a humanitarian supply chain for the delivery of medicaments followed a user-centered approach: several experts working in this domain were interviewed and on the basis of those requirements a first prototype was developed, which was tested by those experts; their feedback was then used to improve the prototype. The development was composed of several iterations till the final version of the system that is presented in next section. The rest of this section reports the structured information that was extracted through the whole design process and that determined the formalization of processes, roles and tasks.

In humanitarian supply chains, all the goods are tracked until the last distribution center, which is a warehouse in charge of replenishing all the pharmacies in a specific geographical area. The delivery from the last warehouse to the final user is called "last mile" and usually this part of the supply chain is not monitored. In this case, the users receive the goods at the pharmacies, which can be either standalone structures or, more often, part of hospitals or clinics. As previously mentioned, in a specific geographical area, the distribution center is a warehouse that has to ship goods to the pharmacies following their orders. The pharmacies have to keep track of their stocks and make orders to be sent to the distribution center, which will process their order and ship the asked goods. Once the requested medicaments are delivered, the pharmacy has to check which ordered medicaments were actually received and update the stock on hand, i.e. the list of available medicaments in the pharmacy.

The pharmacy stocks are updated regularly following a review process where the pharmacy employees have to go in the depot and physically count the remaining items, then fill out a form that will be forwarded to the pharmacy manager, who has to compile the order. The maximum of medicaments that the pharmacy can request is determined by the imprest level. The term "imprest" comes from accounting and for supply chains an imprest system is "A form of periodic inventory control in which stocks are replenished up to a pre-established level. No running stock records are kept. The only stock control document is a preprinted sheet showing each item, its description, the unit of issue, and the imprest level. Generally used only at small facilities" [10]. When using the imprest or quota system, stocks are replenished up to a level called the imprest level at each review period; no running stock records are kept. The only stock control document is a preprinted sheet showing for each item its description, stock number, unit of issue, and imprest level [11]. The imprest level is determined for each type of medicaments and is usually based on a formula that takes into account the pharmacy's remaining stock, the warehouse stock and the previous orders. However, a standard imprest level formula does not exist and every supply chain can establish its own rule.

Based on the analysis of the supply chain process, it was possible to identify 4 different main roles: The system administrator, who has to initialize the data and can do anything from his administration panel; the warehouse manager, who manages the stocks, sets the imprest level for each pharmacy and distributes the supplies to the pharmacies; the pharmacy manager, who passes orders and manages his employees; and finally the pharmacy employee, who can update the supplies in the stock on hand.

4 System

The final prototype allows tracking and tracing drug products, other medical supplies and or nutritional supplies using bar codes as well as using geolocation information via smartphones. In particular, this system is composed of two main parts: a web-based application accessible via any device using a simple Internet browser for operations to be carried while connected. The second part consists of a native application for smartphones, which is cross-platforms, meaning that it can be used on both Android and iOS. This mobile app has been developed in order to be used also offline and to simplify the task of entering information implementing a barcode scan feature. All the data collected with the smartphones will be transmitted to a central data base ensuring transparency and accountability in the supply chain. Finally, this system allows connecting its database to a business intelligence software, i.e., Tableau, which enables efficient data analysis.

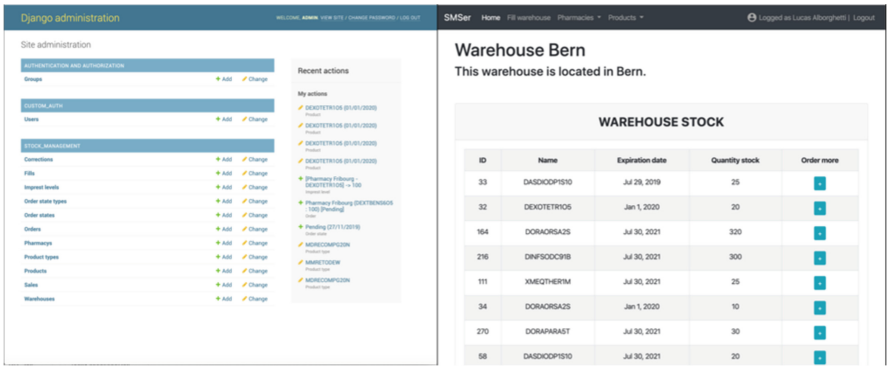

Fig. 1. Interface of the web application: access for the administrator (*left*) and for the other users, here the warehouse manager's dashboard is depicted (*right*).

Users can access the system through the web application, where they have to login and, depending on their role, they will have access to different functions. As mentioned in the previous section, the implemented roles are system administrator, warehouse manager, pharmacy manager and pharmacy employee. Through the web interface depicted in Fig. 1 left, the system administrator can manage the other users' accounts and assign their roles; S/he can also add a new pharmacy or warehouse and associate a user to a pharmacy. Finally, s/he can determine the imprest levels. The warehouse manager can display the pharmacies orders and validate them. Through the navigation bar on top, s/he can also visit other pages to create new products, fill the warehouse, or update the imprest levels (Fig. 1 right). Finally, the warehouse manager can also see pharmacies' stocks. The pharmacy manager can display the current stock on hand (and ordered items) of the assigned pharmacy and navigate to other pages using the navigation bar on top to manage orders and the personnel. The pharmacy employee can

only display pharmacy stock, update the quantity of available products (stock on hand) and enter the information related to the medicaments when they are given to the final beneficiary.

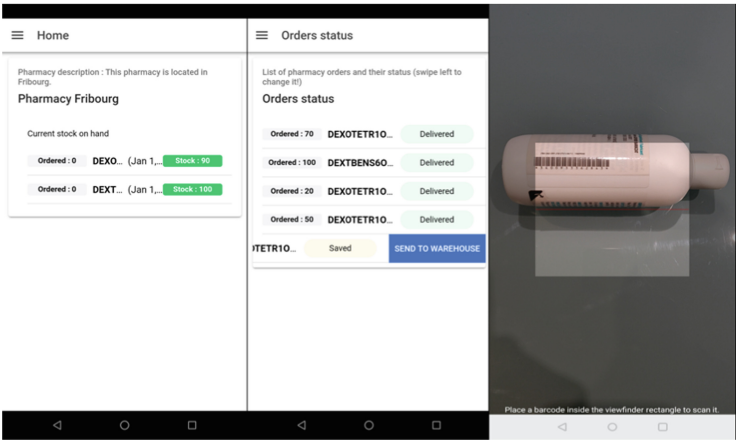

Fig. 2. Mobile application: management of the stock (*left*), managing the orders (*center*) and scan of the barcode to enter the information of a medicament (*right*).

The mobile application replicates the same functions as the ones available through the web interface with two additional features (Fig. 2). First, the mobile application has been designed to work also offline, allowing users to update information that will be kept in a buffer till the connection to the Internet will be available again without losing any changes. Second, this app allows using the integrated mobile camera to scan barcodes for a quick entry of the information related to a medicament for a facilitated update of the stock on hand.

5 Evaluation

The pilot test was carried out at the pharmacy of the ICRC Weapon-wounded Trauma and Training Centre (WTTC) in Tripoli, Lebanon. Two participants took part in the test: the ICRC represented by pharmacist at the WTTC in Tripoli, and the ICRC Medical Logistician for Lebanon from Beirut. The aim of this pilot test was to assess whether the pharmacy employees are able to use such system and which possible problems they can face.

The system was tested on the following tasks: Download and install mobile application from Google Play Store; Access the mobile application on a mobile device; Adding a new pharmacy on the web portal; Adding a new user on the web portal; Adding new products to the new pharmacy on the web portal; Entering an Imprest level

for a new item on the web portal; Updating the stock on hand on the mobile application; Integration of the database with Logistics information system; Integration of the database with Tableau Business Analytics. Both participants were able to complete all the tasks reporting a task completion of 100% and 0% error rate. During the interview, the participants defined the system as "functional", "easy to use" and that can facilitate the management of the medicament stocks and the order process. They also suggested also the following possible improvements: the pop-up window only displays the item which is prone to errors of selection and should be widened to display the entire length of the item description; inquiry about recording demand from wards (out of scope in this test); the table and selection should be searchable by item code and name to find items faster.

6 Conclusion

The digitalization of the last mile of supply chains is expected to solve many problems providing full transparency along the chain, optimizing the management of products and reducing waste. This is particularly important for humanitarian supply chains for the delivery of medicaments since they have to be easy to implement, able to adapt to crisis situations and fast to avoid passing the products' expiry date. This paper presented the user-centered design of a system for the digitalization of the last mile of a humanitarian supply chain. The prototype was tested in a pharmacy in Lebanon to assess its possible adoption in a real-world scenario.

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Comprehensive Strategic Risk Management System to Reduce Evaluation Times in Small-Scale Mining Projects

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Abstract. Mining investment represents high risk for any company within or outside this area, and this has repercussions, above all, for the small companies that do not have any investment capital that they can set aside. The methods used to assess investment projects are traditional, with economic estimates such as the Net Present Value (NPV) to determine the project's profitability. However, these methods do not assess risk factors or qualitative variables, such as socio-environmental factors or the project's limitations on a supply chain. Given the uniqueness of each mining project variable, a systematic tool simplifying variable identification and ensuring an accurate evaluation of the mining project in its prefeasibility stage is required. This research aims to create and implement the Risk Management Balanced Scorecard approach as a project evaluation tool that will help reduce the evaluation times and implement the project risk variables, which will be analyzed by a number of experts with great experience in the industry. The results will determine the project viability or non-viability for investment.

Keywords: Balanced Scorecard · Investment · Evaluation · Prefeasibility · Risk · Mining companies

1 Introduction

In Perú, for small-scale mining companies, which acquire and develop mining projects with production capacities not exceeding 350 tons per day, explorations are specific and are performed with the support of junior exploration companies dedicated to finding and investing in the exploration stage of projects to add economic value. However, unlike large-scale mining companies, these businesses do not have an evaluation methodology

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that allows projects to be assessed as safely as possible. Hence, there is an urgent need to mitigate these investment risks, which are always significant in the mining industry, using an efficient tool that decreases evaluation time and boosts investor confidence.

The Decoupled Net Present Value (DNPV) has been implemented for the evaluation of mining investment projects, taking into account market risks and other factors using technical experts in risk evaluation along with the mining company managers [1]. Real Options Analysis is a risk management technique for managerial decision-making on mining project investments as determining variables for their evaluation because a subsequent investment can be added to the initial investment to promote the project and exceed the expectations of the project's economic rate of return [2].

2 State of the Art

2.1 Mining Risk Management System

Five relevant risk categories have been identified in terms of investment: association's risks, technical risks, climate risks, market risks, and economic risks [3]. Identifying risk management as a determining factor for the development of mining companies, Kinross Corporation implemented a risk management strategy in all its processes through strategic planning using the Balance Scorecard (BSC) to assess its processes, with data obtained from statistical processes [4]. The Extended TOPSIS technique combines the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) with Linguistic Neutrosophic Numbers (LLNs) for mining project evaluation, and the result will be obtained after applying a series of mathematical analyses wherein uncertainty scenarios and decision-making problems are considered [5]. Risk identification in mining processes is required to assess a project, which must meet all the geological conditions guaranteeing a potential ore body to be considered as a project [6].

2.2 Strategic Risk Management System in Mining

Systematization requires variables that can serve as input values for the formulas to be used by project assessors. Some of these identified variables cannot be quantified because they are qualitative; uncertain variables, whose future value is unknown, will be considered as risk variables. The Gabriela Mistral copper project in Chile was assessed using systematization from Stage I, data collection; Stage II, probabilistic reserve model by means of a block model; Stage III, mine design and production planning; Stage IV, economic model; Stage V, risk variable quantification, building a robust investment project [7]. The Sossego mine in Brazil was expanded through a data collection process wherein various uncertainty scenarios were considered. The result presented a diamond exploration plan, which was approved by management, as it was a critical variable that could affect the project in future [8].

3 Contribution

3.1 Rationale

The proposed system uses the risk management technique to assess small-scale mining projects. It will be divided into five stages for implementation, which will be connected and conditioned by the immediately preceding one; thus, each stage will have deliverables demonstrating the results (Fig. 1).

The five stages of the mining project evaluation system are prepared so as not to leave aside any internal or external variable, as relevant as it may be for the project. These stages are classification according to the experience of specialists in the field; determination of the environmental risk using statistical data verified by governmental institutions; presentation of results through a strategic planning scheme used to visualize changes in values over a three-year period; and project monitoring and control through the BSC. Each stage is detailed according to its specific characteristics and development tools.

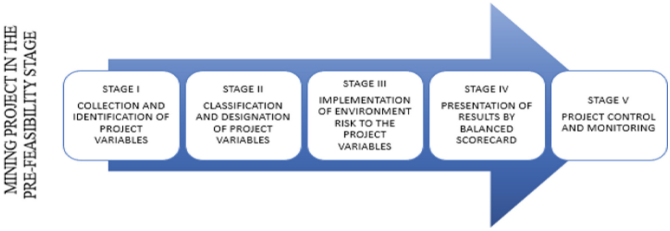

Fig. 1. Stages of the risk management system

3.2 Proposed Methodology

Associating a high exploration investment with favorable conditions for the mining industry development entails lower risk. In contrast, in a scenario wherein investment in mining exploration is set aside because of various adverse factors, mining investment risk is higher because the minimum conditions for the development of the mining industry are not met.

The risk percentage is calculated for each year, i.e., from 2005 to 2018; the standard risk is the average sum between the maximum percentage value for investment and minimum percentage value for investment. Next, this average is subtracted from the annual percentage value to obtain the risk value for this study. To guarantee the results with the risk percentage associated by the management area of large-scale mining companies to their projects, five senior management members of different companies such as El Brocal, Barrick Gold Corporation, and the National Society of Mining, Petroleum and Energy (SNMPE, for its Spanish acronym) of Peru, which associate similar risk values through risk management decision-making tools, were consulted.

3.3 Indicators

As previously mentioned, the time factor must be taken into account in the analysis of project risk variables, as with the passage of time, the variables will be affected by the project environment. The BSC is the management tool that integrates all the project evaluated areas and measures their evolution over time, and it will present the results in a comprehensible manner for the evaluating party and the project owner. When risk management is integrated into the evaluation system, it will be designated as a Risk Management BSC; when using previous data collection tools, the BSC will show only results justified and controlled over time.

4 Validation

The risk management system was implemented in the Huayllapa small-scale mining project owned by the Peruvian Metal Extraction and Marketing Company (COMPEXCOM), which has 400 hectares (ha) and is located in the Copa district, Cajatambo province in the Lima–Peru region.

4.1 Identification of Project Variables (Stage I)

The variables will be identified in the risk management system through checklists, which will be delivered to the experts in the field. Depending on the experts' technical or managerial area, they will be provided with a checklist focused on their field of specialization.

The variables are as follows:

Geology Area: 1 Regional Geology, 2 Local Geology, 3 Structural Geology, 4 Analysis of Project Samples, 5 Soil Survey, 6 Hydrogeology, 7 Geophysics, 8 Diamond Drilling, 9 Trial Pits, and 10 Ore Reserve Estimation.

Mining Area: 11 Mining Plan, 12 Former Works, 13 Software Simulation, 14 Defined Mining Methodology, 15 Experienced Mining Workers.

Legal Area: 16 Integral Registry of Mining Formalization, 17 Certificate of Small-Scale Mining Producer (PPM), 18 Mining Operation Certificate (COM), 19 Memorandum of Agreement with Surrounding Communities, and 20 Easement Agreement.

Economic Area: 21 Initial Investment Amount, 22 Analysis of NPV, 23 Analysis of IRR.

Infrastructure Area: 24 Surface Land Surveying, 25 Mining Camp Preparation, and 26 Logistics Works.

4.2 Classification and Designation of the Huayllapa Project Variables (Stage II)

Seven variables out of 40 have been discarded because they do not have a direct impact on the evaluation or development of the Huayllapa project, leaving only 33 for valuation. Table 1 presents the result of 18 as the final value of the sum of values of all the

areas described. However, this will be a partial result, as the environmental risk has not been considered to the resulting values.

Table 1. Designation of Huayllapa project variables

Variable classification and designation						
No.	Variable	Designation of Huayllapa project risk variables				Σ by area
		Very risky (−2)	Risks (−1)	Low risk (1)	No risk (2)	
1	Geology area	−2	0	3	8	**9**
2	Mining area	−2	0	1	2	**1**
3	Infrastructure area	−4	−1	0	2	**−3**
4	Economic area	−4	0	4	8	**8**
5	Legal area	−2	0	1	4	**3**
	Sum of results	−14	−1	9	24	**18**

4.3 Analysis and Addition of Environmental Risk to the Huayllapa Project (Stage III)

Considering the proposed system methodology, the 2018 investment risk is added, and the percentage value is 14.22%.

The resulting value is TM = 9.44 (I) in the BSC, it represents a risk for the Huayllapa project. Through the management system, the necessary procedures to obtain operating permits and to develop the semi-detailed Environmental Impact Study, the mining plan, the Start/restart of operations, and the qualification of Small-Scale Mining Producer are recognized as a TM risk variable.

OM represents the highest risk for the Huayllapa project, with a resulting value of −1.14 (II); according to the risk management system, it is mainly because of the lack of access to the project.

The estimated resources of the Huayllapa project have a strong content of silver, copper, and zinc metals that have a significant average grade in the metallurgical accounting, making it attractive for investment. However, it does not achieve a green value for not presenting a diamond drilling plan that ensures the proved and probable resources of the Huayllapa project.

4.4 Development of the Risk Management Balanced Scorecard for the Huayllapa Project (Stage IV)

By combining the risk management technique to the strategic planning tool of the BSC to evaluate the Huayllapa project, a partial result is achieved that is complemented by the results obtained in years 1, 2, and 3, wherein the Huayllapa project evolution is controlled. The Huayllapa polymetallic project has achieved a resulting value of 16.02 (Sum of values I, II and III), i.e., it presents a moderate risk for investment.

4.5 Huayllapa Project Control and Monitoring (Stage V)

Investment limitations will be individual for each area. For the mining area the main limitation will be the type of rock and the maintenance costs necessary for the selected mining plan. For the geology area, the main limitation will be the impossibility in affording diamond drillings that ensure probable or proved reserves. For the legal area the main obstacle will be the time and investment necessary to obtain exploitation permits. For the economic and infrastructure areas, the investment in the construction of accesses, necessary for the transport of minerals and personnel from the mine to their final destination, will entail a high initial investment cost and, thus, a great future risk due to the national political instability.

5 Conclusions

The Huayllapa project risk variables were classified and identified using the BSC planning tool, resulting in a value of 16.02. The analysis revealed that the OM area has the highest investment risk for the Huayllapa project because of the amount of capital required to condition accesses. This is followed by the exploration area, where although there are indicated and inferred reserves, these should be transferred to the proved reserves through a diamond drilling plan that ensures the continuity of ore bodies in the project. Finally, the project's social and legal risks for the senior management area were identified.

Management of industry-related risks is implemented according to the level of investment in Peru's mining exploration in 2018, which leads to a risk of 14.22% for investments in small-scale mining projects.

Risk management systematization was used to implement the BSC tool, with a result of 16.02 as final value. This value will change according to the control and monitoring of the Huayllapa project risk variables over a three-year period to determine its viability throughout this period.

The proposed systematization reduces the mining project evaluation time by approximately 30%.

Finally, the Huayllapa project was found to be viable for investment because of its geological potential and social support from surrounding communities. A mitigation study should be conducted for the most relevant risks identified.

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Intra-work Conditions. Objective of the Organizational Management for the Healthy Company

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Abstract. Corporate responsibility in the protection and safety of workers is daily relevant in the management of occupational risks. To evaluate the intra-labor conditions to determine those precursors of symptomatology that can affect the worker's physical and mental health, and activities for psychosocial risk management. Methods, mixed type study with a descriptive approach, carried out in 7 service companies, with 263 workers. The sample was 260 workers. The workers signed the informed consent for the collection of information. Application of the instrument battery questionnaires for the evaluation of psychosocial risk factors, which has reliability levels for intra-labor conditions of 0.957 and stress of 0.83 [1]. Organizational management strategies must include periodic evaluation, monitoring and control of psychosocial factors. The due development of plans and programs, as well as the appropriate intervention, improves working conditions and productivity, making this a healthy company.

Keywords: Work environment · Psychosocial · Intra-work · Safety · Health

1 Introduction

The management, organization and management of occupational safety and health should be at the heart of strategic planning, since it is about protecting the worker against the risks of work that threaten the physical and mental health of the worker.

These risks caused by conditions in unhealthy work environments, practices such as promotion and prevention strategies that are null or inadequate, coupled with organizational behaviors and dispositions that focus only on production, ignoring the well-being of the worker, leaving aside the health and welfare of collaborators.

Working environments in the global context perform organizational practices that ignore psychosocial factors, ignoring labor legal initiatives, favoring practices that leave aside values such as respect, good treatment, dignity and healthy coexistence, towards scenarios of non-arbitrariness and no work violence.

International institutions such as the World Health Organization make repeated calls about the influence that work stress has within organizations, determining it as "high risk" in the probability of affecting the greatest number of individuals being highly vulnerable workers and your families. Unlocking situations in which health

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deteriorates, affecting the performance of companies due to absences or diminished individual development with respect to their work with a significant decrease in productivity, leading to an increase in accidents, the appearance of occupational diseases or rotation permanent staff [2].

Thus, in today's world it develops in a significant increase with respect to work demands. In 1991 the European Union determined that "the proportion of workers who complain of organizational problems are directly associated with stress and is higher than the proportion of those who complain of physical problems" [3].

With a high influence on the performance of workers, in such a way that they experience a loss of productivity, caused by alterations, in many cases of work origin, with deterioration in the quality of life of workers, their basic family nucleus and that of their environment, making them even more socially vulnerable.

These conditions fulfil the denomination of psychosocial factors that include aspects of the position and the work environment, climate or organizational culture, functions; interpersonal relationships, design and content of the tasks included here the variety, meaning, and scope, repetitive or monotonous character, among others.

The organization of work and organizational factors are determined in this study as synonymous with psychosocial factors, referring to working conditions that can activate situations of work stress.

Occupational risk management is an activity of great importance in the administration and business management of any productive sector. This constitutes the key element for the daily development of the processes that are advanced and, consequently, of the organizational management.

Employers must assume the responsibility of providing protection and safety, with the adaptation of places and elements so that collaborators do their work without harm, thus promoting healthy business [2].

The concept of a healthy company understood as one that cares about continuously improving the health of its workers inside and outside work. This promotes happiness, leadership, authenticity, respect for the other, culture and personal growth, this dynamic is endorsed and promoted to nations by the World Health Organization (WHO) and the International Labor Organization (ILO), as part of ethics, business interest, law and as a global requirement [4].

A healthy work environment is a place where united workers achieve a joint vision of health and well-being. Providing workers with physical, psychological, social and organizational conditions that protect and promote health and safety. This allows bosses and collaborators greater control over health, making them more positive and happy [5].

Therefore, it is necessary to study and analyze conditions in work groups that have a high level of requirements.

In the world of work, although reliable tools are available for the measurement of psychosocial factors at work, companies lack knowledge about the organizational benefits of proper and permanent identification of these risk conditions.

This is the case of the companies under study. That knowing of the national legal requirements [6], proceeded to perform the evaluation, obtained important data to include them in the management of safety and health at work and for decision making within the strategic planning in the fulfilment of the objectives, and of the standards required by their customers.

2 Method

This study, identified the intra-work conditions of the psychosocial factors, conformed by four domains: demands of work, control over work, leadership and social relations at work and reward; verifying symptomatology regarding work stress.

The method used was to determine a mixed type study with a descriptive approach. A defined population in 7 service companies of the city of Bogotá D.C. A total population of 263 workers with positions of leadership and operation or support. The factors of psychosocial risk intra-work, stress and the affectation in the physical and mental health were determined.

A sample of 260 workers was included who signed the informed consent for the collection of information, data processing and use of the same.

Use of the battery questionnaires of Colombian psychosocial risk factors instruments, with levels of reliability for intra-work conditions of 0.957 and stress of 0.83, verifying the influence on the worker's physical and mental health [6].

The intra-work questionnaire analyzes the conditions of work and the dimensions addressed:

a. Demands of work: regarding the environment and physical effort, emotions, the amount of work, the influence of work on the extra-work environment, the demands, the mental load, and the consistency of the role and the demands of work.
b. Control over the work: verifying the clarity of the role, the training that the worker receives, the participation in the change, the opportunities to use their skills and their development, and the control and autonomy they have over the work.
c. Leadership and social relations at work: which evaluates the characteristics of leadership, the relationship with employees and subordinates, social relations at work and performance feedback.
d. Rewards: analyzing the recognition against the work they do and the group to which they belong and the reward derived from belonging to the organization.

The study conducted ethical information management of the workers who participated.

3 Results

The study allowed us to see the general panorama of the psychosocial conditions within the workplace and of the stress conditions, of the employees in charge of headship and operatives, thus:

3.1 Factor Intra-work Risk - Form A

The workers in charge of the head office, register in a low level of risk and very low in the psychosocial intra-work factors. Becoming this one, in a protective factor for 100% of the workers of this level.

A higher salary scale, hierarchical position in the company that provides them with better working conditions, regarding the management of their time and satisfaction, are the factors that protect them.

3.2 Intra-work Risk Factor - Form B

For employees with an operational charge, 41% of the respondents report the presence of psychosocial risk factors inside the workplace.

The indicators show that 16% of workers have "Very High" risk level, 18% in "High" risk level and 27% in "Medium" risk level.

In addition, they have levels of involvement in "High" and "Very High" in the domain leadership and social relations at work, control over work and demands of work.

The assessment of stress for workers in charge of leadership and operations shows that 29% of employees have a level of risk "High" and "Medium".

Workers psychosomatic conditions with high levels of anxiety and physiological effects such as headaches and excess fatigue.

3.3 Stress Conditions

42% of workers reveal symptoms associated with work stress.

Next, the results in Table 1 describe the discomfort reported by the workers, where 32% of the population affected by stress presented disabilities greater than 3 days in the last 3 months:

Table 1. Symptoms derived from stress at work.

Symptom	Disconforts	Affected population
Physiological	Muscle pain in the neck	15%
	Gastrointestinal disorders due to irritable bowel and constipation	
	Tension headaches	
	Daytime sleepiness	
	Palpitations	
Social behavior	Feeling and overload at work Feeling of irritability	12%
Intellectuals and labor	Feeling of frustration	7%
	Fatigue or reluctance	
Psychoemotional	Consumption coffee or cigarette Sensation of isolation and disinterest Rigid behavior and stubbornness	8%
Total		42%

In Table 1: The symptoms represent alteration in the workers. However, the most representative corresponds to physiological symptoms with 15%, followed by social behavior with 12% at risk "High".

4 Discussion

The influence of psychosocial risk factors within the workforce bosses, is diminished in their affectation, because these activities privilege the worker in this range, to give freedom in the handling of time, and better remuneration, however, it is necessary that companies determine clear work protocols that prevent privileges that reduce the health and well-being of those who lack them.

The owners of the company perform managerial positions. Those who are very satisfied with the fulfilment of the proposed objectives.

Low management in aspects related to occupational safety and health that increase the risk of exposure of workers to emerging psychosocial risks.

It is necessary to incorporate in the process of organizational management, the development of identification, evaluation, permanent monitoring and intervention of psychosocial risk factors, addressed from the intervention plan of the health and safety at work management system, with the to improve the conditions of quality of life and mental health of workers.

For the intervention plan, it was determined as Priority 1. The verification of the salary conditions of the workers, as Priority 2. The development of plans and programs that lead the worker to generate behaviors in development of their self-esteem and personal care at work.

5 Conclusions

It is evident that the State must reinforce efforts to raise awareness on the part of the business class, so that they understand that epidemiological surveillance programs for the prevention of psychosocial risk is determined as a key strategy for the management of organizations and the consolidation of a healthy and highly productive company.

Companies must allocate adequate and sufficient resources for the development of psychosocial activities.

Obtaining a healthy company constitutes, for this study, the main objective.

The improvement of the physical working environments, good interpersonal relationships, emotional health, promotion of the family and social well-being of the workers, constitute the prioritized dynamics of protection [7].

All this for the development of environments that promote self-control and responsibility towards the health of each worker, making these places of work, healthy spaces and where everyone wants to work.

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Safety Management Model with a Behavior-Based Safety Coaching Approach to Reduce Substandard Behaviors in the Mining Sector

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Abstract. This study addresses the implementation of a behavior-based safety coaching model to reduce the occurrence of substandard acts in an underground mining company in Peru. The previous database of accidents and incidents provided by the mining company was analyzed to prepare data tables of the degrees of accidents and safety-related incidents. Then, the highest-risk activities are considered with respect to the behavior-based safety model to observe workers. The substandard acts are examined, and an action plan was drafted using the behavior-based coaching model according to the safety management model adopted in the mine. This paper examines the application of a safety management model in an underground mine in Peru by collecting and observing data through the behavior-based safety model, proposal of solutions under the coaching model, and analysis of the final results of substandard behaviors obtained with respect to the initial behaviors.

Keywords: Management model · Behavior-based safety · Coaching · Substandard acts · Mine safety

1 Introduction

According to the safety indicators published by the Peruvian Ministry of Energy and Mines, there were 29, 34, 41, and 27 fatal accidents in 2015, 2016, 2017, and 2018, respectively. However, these figures do not consider the number of incidents and minor or disabling accidents. These events are sometimes caused by poorly maintained equipment, unfavorable working conditions, or a lack of information from employees.

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Research on worker behavior showed that 90% of incidents and accidents are caused by substandard acts, which is one of the most influential causes of mining accidents [1].

Behavior-based safety (BBS) was formulated in Russia by psychologists Ivan Pávlov and Vladimir Bechterey. Although there are multiple techniques to prevent injuries in the mining industry through traditional safety management systems, the combination of these two tools, BBS and the triconditional behavior model, favors an efficient interper-sonal process of observation and feedback [2].

2 State of the Art

Safety Management Model. It is aimed at preventing incidents and accidents in industries, shifting from a reactive system to a proactive, which benefits companies and organizations and develops safety culture [3]. During the past several decades, safety was aimed at achieving business sustainability, wellbeing, and quality of life across the organization. However, the occupational health and safety system does not cover these concepts or involve a single area; instead, it encompasses corporate management, occupational health, and safety and environmental management as supplementary components [4, 5].

Behavior-Based Safety. At present, BBS has reduced accident rates by altering unsafe human behavior because it is the leading cause of workplace accidents [2]. Heinrich studied 70,000 accidents and found that 88% of these accidents were caused by unsafe acts performed by workers, 10% by unsafe working conditions, and 2% by force majeure. Finally, BBS is strongly linked to motivation because it arises from people's needs and plays a major role in inspiration, leadership, and strength [6].

Safety Coaching. Safety coaching is based on observation and feedback to reduce workplace errors [7]. BBS and coaching should be implemented as methods to reduce mining incidents/accidents. It was shown that accident rates reduced when BBS was adopted in an entity [8]. The combination of BBS and a follow-up system may create a solid system that may be activated on a continuous basis and improved over time [9].

3 Contribution

3.1 Proposed Model

The contribution of this research project is a safety management model to reduce substandard acts using tools to study and consolidate worker behavior in the Peruvian mining industry (Fig. 1).

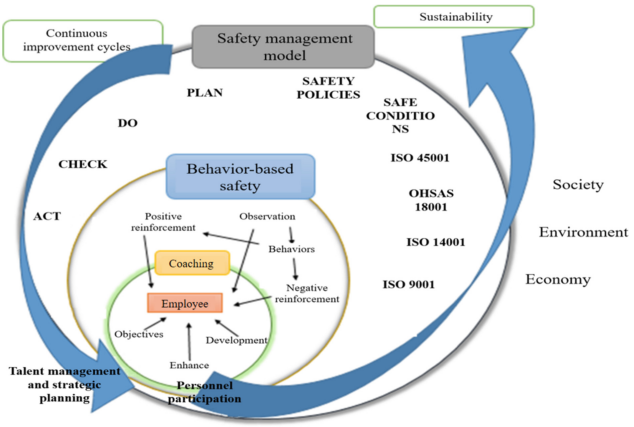

Fig. 1. Comprehensive safety management model

3.2 Detail View

The proposed method consists of the following:

- Analyzing accidents by collecting company data.
- Analyzing the data gathered through tables and bar charts displaying the tasks with the highest incident/accident rates.
- Readjusting BBS observation sheets to the activities chosen with the safety area for implementation purposes.
- Preparing the field model for observers used to select the group of company workers. These observers will observe and complete the sheets.
- Collecting and analyzing the observation sheets to verify their validity.
- Designing the group coaching sessions with a specialized coach aimed at the tasks with the highest incident/accident rates.

3.3 Process View

The process flowchart is shown in Fig. 2.

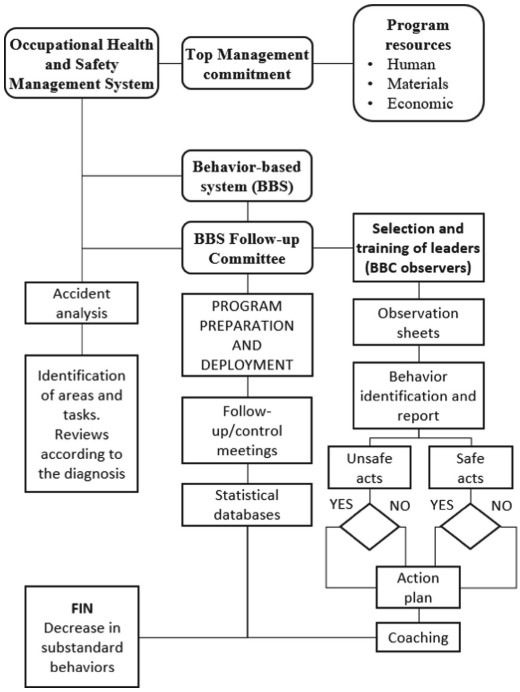

Fig. 2. Process flowchart

3.4 Indicators View

Reducing Incidents and Accidents. This indicator will be used to create a safer organizational culture.

Reinforcing Workers' Safe Behaviors. This indicator will be used to reduce sub-standard acts performed by operators.

Boosting Productivity. This indicator will be used to boost productivity because it prevents the cessation of work and economic losses caused by potential accidents.

Minimizing Downtime. This indicator will enhance downtime in mining operations caused by any potential accident in the mine.

4 Validity

4.1 Case Study

The safety management model under the aforementioned behavior-based safety coaching approach will be implemented in the Minera Tauro contract company, which renders services to the Poderosa mining company located in Pataz, La Libertad, Perú.

4.2 Initial Diagnosis

Table 1 show the initial status of Minera Tauro based on the results: incident (INC), dangerous incident (DI), minor accident (MA), disabling incident (DI), and fatal accident (FAT).

Table 1. Total incidents and accidents in 2018

Month	MA	INC	DI	FAT	DI	Total incidents accidents
Jan.	4	11	0	0	0	15
Feb.	0	8	4	0	0	12
Mar.	0	9	0	0	0	9
Apr.	3	8	2	0	0	13
May	3	6	0	0	0	9
Jun.	3	7	1	0	0	11
Jul.	2	6	0	0	0	8
Aug.	1	8	1	0	0	10
Sep.	3	4	1	0	0	8
Oct.	4	6	0	0	0	10
Nov.	1	5	1	0	0	7
Dec.	1	6	2	0	0	9
Total	25	84	12	0	0	121

Based on the database, the events with the highest rate of accidents were rockfalls 23 and falls 18; therefore, these two events were used as the preliminary criteria to conduct the research (Table 2).

Table 2. Total incidents and accidents in 2018 according to the type of event

Type of event	Total
Worker trapped by fall of ground, slide, mineral blowing or earthmoving	10
Worker caught-in or struck by, machinery in motion	12
Fall of worker	18
Worker struck against or by objects while handing materials	9
Rockfall	23
Excessive efforts or false movements	9
Exposure to, or contact with, electric energy	9
Worker struck by tools	11
Worker struck by flying objects when detonating explosives	3
Other (specify)	17
Total	121

4.3 Contribution to the Test Scenario

Safe Behaviors per Task. The shift worker observation points were defined (three observation points of two workers per shift engaged in the removal of loose rocks and supporting tasks, and two observation points of three workers per shift engaged in shaft works). Observations were conducted for 7 days and 241 sheets were produced: 78 for the removal of loose rocks; 81 for supporting tasks; and 82 for shaft works.

Removal of Loose Rocks. Safe behaviors related to the removal of loose rocks stand at 90.68%. The leading unsafe behavior is the failure to use "protective goggles according to the activity conducted" (42%), followed by "appropriate gloves according to the activity performed" (36%), "clean helmet and hearing protectors in good condition" (19%). In addition, the behaviors with the greatest proportionality margins upon conducting the tasks are "verify the fall projection of the bank when the loose area falls" and "verify crowbars (tip and nail of the crowbar)" standing at 39% and 32.

Supporting. Safe behaviors related to supporting tasks amount to 90.99%. The leading unsafe behaviors are the failure to use "appropriate gloves according to the activity performed (in good condition)" and "protective goggles" at 35% and 38%, respectively.

High-Rise Work (Shafts). Safe behaviors related to shaft works stand at 93.29%. Unsafe behaviors are mainly related to the failure to use "protective goggles according to the activity conducted" (54%) and the leading unsafe behavior in high-rise tasks is related to works on safe surfaces (55%).

A total of 333 observations were collected from staff members, which is the total of the frequencies of all the subcategories. After performing the first session, participants discovered that they had no clear, measurable, and achievable goals, and this session helped them get better organized. In the second session, the 36 attendants were provided with the GROW methodology as a tool to propose specific objectives to accomplish their goals in the short term. After the coaching sessions, BBS observation sheets were reimplemented to compare safe behaviors before and after coaching. After the coaching sessions, the outcomes of the data collected using the BBS sheets showed the following safe behavior percentages: removal of loose rocks (92.53%), support (91.30%), and shaft (93.83%) (Tables 3 and 4).

Table 3. Analysis of conceptual contents.

Name	Frequency
Time (T)	**Frequency**
Time management	18
Deadline	13
Invested time	7
Time availability	12
Information (I)	**Frequency**
Lack of information	2
Documentation	4
Benefits (B)	**Frequency**
Set goals	14
Measurement of objectives	20
Achieved results	17
Writing objectives (EO)	**Frequency**
Feedback	8
Performance	13
Approach	10
Intrapersonal relationships (R-INTRA)	**Frequency**
Awareness	17
Saturation	25
New ideas	20
Adaptability to change	26
Individualism	9
Indecision	5
Accountability	17
Interpersonal relationships (R-INTER)	**Frequency**
Impulse	14
Personal relationships	13
Teamwork	10
Motivated employees	11
Relationship with others	16
Abandonment of relationship with others	12
Total respondents	36
Total items	333

Table 4. Percentage of safe behaviors per activity

Task	Percentage of safe behaviors		
	BBS (%)	BBS + coaching (%)	Change (%)
Removal of loose rocks	90.68	92.53	2.040
Support	90.99	91.30	0.341
Shaft	93.29	93.83	0.579

4.4 Outcomes

From the total incidents observed in 2018 and part of 2019, there is a slight decrease during the adoption of the behavior-based safety coaching approach, with a total of 45 incidents as opposed to 58 incidents in the previous year until May. From these results, a bar chart of total accidents and incidents over the two years was prepared and assessed (Fig. 3). This chart denotes a downward trend in accidents.

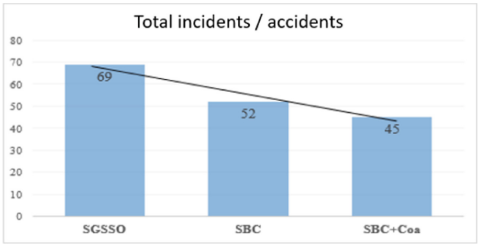

Fig. 3. Total incidents and accidents according to the safety system

5 Conclusions

This research project employed the behavior-based safety coaching approach at Minera Tauro SAC with favorable outcomes; it made a positive impact in the first week of adoption. Coaching has produced evidence that demonstrates that it is an efficient corporate tool. In addition, there is evidence that coaching may be an efficient way to improve the safety outcomes in some critical environments, particularly when it is used as part of broader occupational health and safety approach. Moreover, the study denoted the base used for the implementation of behavior-based safety coaching programs, particularly on falls and rockfalls with a rate of 18 and 23 incidents/accidents, respectively. It was concluded that observation through BBS sheets regarding the removal of loose rocks, support, and shaft works may be a guide for the contractor company to obtain measurable worker-behavior data while conducting these or other tasks to build up a larger database that may be used to generate continuous improvement through assessments and corrections. Using the BBS sheets, the observed safe behaviors were recorded for subsequent assessment (removal of loose rocks, 90.68%; support, 90.99%; and shaft works, 93.29%).

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Public Management Model with a Sustainable Development Approach Based on Lean Six Sigma: Formalization of Small-Scale and Artisanal Mining in Peru

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Abstract. Accordingly, shared knowledge has enabled the population to focus on this area, the majority of which comprise small-scale informal miners. The government and population must be able to control the informal extraction of minerals and its resulting environmental and social impacts. As such, this study aims to increase the number of formalized small-scale and artisanal miners in accordance with Peruvian regulations. The primary motive is to create a knowledge model based on managing the formalization of small-scale miners. Through this approach, this study contributes to sustainable development in cooperation with the state for informal miners and the neighboring communities. A public management model with a sustainable development approach based on the Six Sigma methodology is proposed to increase the formalization of artisanal miners. Through this methodology, the revision and documentation of the formalization process in the mining sector has improved by 29.3%.

Keywords: Public mining management model · Sustainable development · Small-scale and artisanal mining in Peru · Lean Six Sigma

1 Introduction

In recent years, numerous countries have taken the initiative to formalize small-scale and artisanal mining at a global level. This initiative has been undertaken considering that an estimated 40 million people work in the mining sector worldwide, with 150 million people being directly or indirectly dependent on it. Its positive financial effects are notorious in rural areas; however, approximately 80% of miners are informal, which poses a challenge for all countries in ensuring sustainable development in the

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mining sector [1]. According to the Ministry of Energy and Mining (MINEM), there are an estimated 500 thousand artisanal miners within the national territory. Furthermore, only 54,000 mining activities have been entered in the latest registry of formalized mining operations in Peru. Small-scale and artisanal mining impacts one million people who either directly or indirectly financially depend on this sector. Furthermore, small-scale and artisanal mining contributes 10–12% of the annual national production of gold.

Developing a management model based on Lean Six Sigma will reduce attention times and increase the number of documents evaluated by the Ancash Regional Directorate of Energy and Mines, in addition to simultaneously increasing the number of formalized miners. This study proposes the development of a public management model based on the Lean Six Sigma methodology to improve the formalization process of small-scale and artisanal mining. Formalization improves work conditions, introduces methods to care for the environment, reduces social conflicts, and enables miners to sell their minerals in legal markets.

2 State of the Art

2.1 Public Management Model

Artisanal miners need to be organized into cooperative groups, with training provided to both the miners and those responsible for formalization [2]. This has been similarly proposed in Ghana to improve the regulation of artisanal mining for reducing the impacts and social conflicts generated by artisanal mining. This process comprises organizing miners into cooperative groups, training them on mining and environmental subjects, and granting mining concessions through state companies. Furthermore, obtaining licenses should be more cost-effective, and its processes should be decentralized and moved to communal or local authorities for better control and monitoring [3] of areas to large mining operations [4].

2.2 Lean Six Sigma and Sustainable Development

According to the authors [5–7], the integration of Lean Six Sigma and sustainability concepts is a new theme in the research field. A review of research articles has indicated that the Lean Six Sigma methodology with a sustainability approach can be applied to 13.2% of the metallurgical sector (metal industry). This model can be applied by integrating economic, environmental, and social factors. This approach can in-crease benefits and reduce the negative impacts on the social and environmental components. The authors stated that organizations achieved social, environmental, and eco-nomic benefits by integrating sustainability and Lean Six Sigma improvement methodology.

3 Contribution

3.1 Proposed Model

Figure 1 presents a management model with a sustainable development approach based on Lean Six Sigma to formalize small-scale and artisanal mining.

- The assignment of areas for small-scale and artisanal mining determines the areas where mining activities can be undertaken and helps avoid conflicts with large-scale mining operations.
- Technical assistance will help train miners for responsible extraction and mineral processing processes.
- Analysis of the context of small-scale and artisanal mining identifies the real conditions in the field of operations.
- There must be decentralization of regulatory attention and transfer to local authorities.
- Organization of miners in cooperative groups helps to train miners and provide technical assistance so that they can jointly cover the expenses of the formalization procedures.
- This base model must be statistically monitored to verify progress through the Lean Six Sigma methodology and its DMAIC phases based on statistical tools for data processing.

3.2 Proposed Method

The proposed method is shown in Fig. 2.

4 Validation

4.1 Case Study

The Ancash Region of Peru is located in the central-western sector of the country. To the south, it borders the Lima Region; to the west is the Pacific Ocean; to the east are the Huánuco Region and La Libertad; and to the north is La Libertad, with its capital being the city of Huaraz; which is approximately 402 km from the city of Lima. The study sample comprised 3106 informal small-scale and artisanal miners in the Comprehensive Mining Formalization Register (REINFO) as of 2018 in the Ancash.

4.2 Applying the Contribution to the Test Site

Measure. This figure depicts the evaluation and revision time of the environmental management instrument, displaying an average evaluation time of 91 days (Fig. 4).

This figure indicates the evaluation and revision time of the environmental management instrument, showing an average evaluation time of 112 days (Fig. 5).

Analyze. Identify the main difficulties faced by small-scale and artisanal miners in formalizing through the new comprehensive mining formalization procedure.

A Pareto chart is made to indicates the incidence of formalization requirements not submitted by artisanal miners in the Ancash Region, despite having been already registered in the process.

Improve. The revision and evaluation process for formalization improved by approximately 77.29%, according to the Six Sigma level, indicating a high efficiency of the formalization process (Table 1).

Control. This Fig. 5 indicates the optimum evaluation time of the environmental management instrument.

This Fig. 6 indicates the optimum evaluation time of the technical file (Fig. 3).

Table 1. Indicators

N°	Indicators in the comprehensive mining formalization process	Submitted initial	Submitted final
1	Sworn affidavit to change CIRA	280	765
2	Property Accreditation or Surface Land Use Authorization (TS)	224	763
3	Accreditation of Ownership, Assignment Contract or Exploitation Contract of the mining concession (CM)	166	724
4	Environmental management instrument (IGAFOM) or (IGAC)	148	775
5	Technical file (EP)	101	678
	Total	919	3705

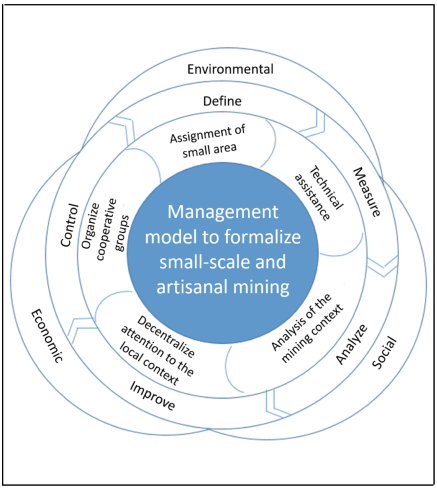

Fig. 1. Contribution to the mining formalization process

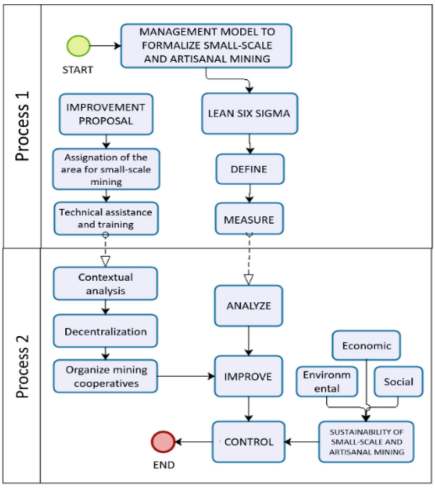

Fig. 2. Proposed method

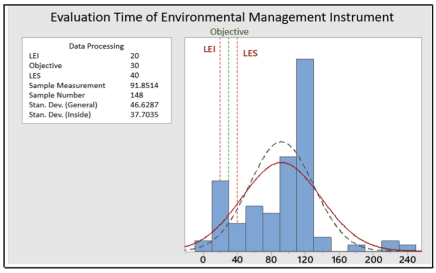

Fig. 3. Evaluation time of environmental management instrument

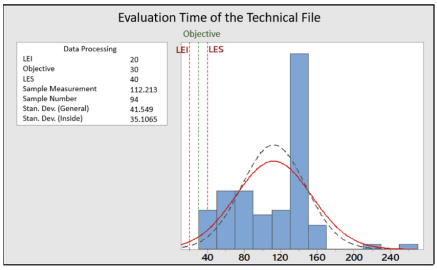

Fig. 4. Evaluation time of the technical file

4.3 Sustainable Development Proposal

Social Pillar: Generate development opportunities for the workforce with all occupational health and safety requirements and by complying with labor standards.

Economic Pillar: Contribute to tax collection, generate revenue and profits from the sale of minerals, and operate and meet the standards for mining operations.

Environmental Pillar: Carry out mining operations while controlling their environmental liabilities and impacts.

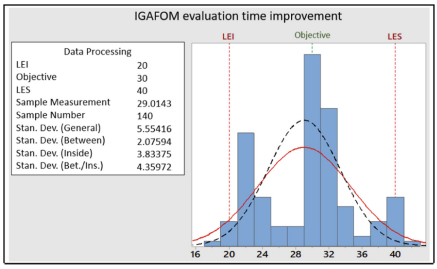

Fig. 5. IGAFOM Evaluation time improvement

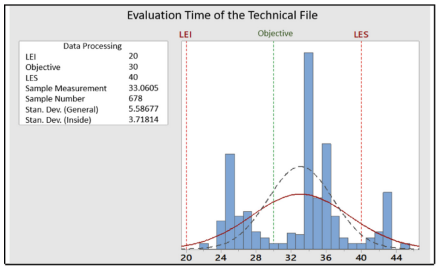

Fig. 6. Evaluation time of the technical file

4.4 Analyzing the Results Obtained

With the methodology proposed on the basis of theoretical research, the following are estimations of the indicators. Accordingly, 678 technical files will be processed and evaluated in one year (Table 2).

Therefore, the estimated performance improvement is from 49.17% to 77.29%, increasing the performance of the revision and evaluation process for the formalization documents by 28.12% (Table 3).

Table 2. Requirements

N°	Requirements for the comprehensive mining formalization process	Submitted
1	Sworn affidavit to change CIRA	765
2	Property Accreditation or Surface Land Use Authorization (TS)	763
3	Accreditation of Ownership, Assignment Contract or Exploitation Contract of the mining concession (CM)	724
4	Environmental management instrument (IGAFOM) or (IGAC)	775
5	Technical file (EP)	678
	Total	3705

Table 3. Comparison

Before	After
PPMO = 510,000	PPMO = 226,800
Sigma level = 1.48	Sigma level = 2.24
Performance = 49.17%	Performance = 77.29%

5 Conclusion

The Six Sigma methodology has been applied with a sustainability approach to strengthen the formalization process of small-scale and artisanal mining in the Ancash Region. The process is carried out by the Regional Directorate of Energy and Mines, who depends on the Directorate General of Mining Formalization of the MINEM. The study results indicate that formalization can be improved and negative environmental impacts can be reduced. This measure would increase job security and tax contributions, in addition to controlling and monitoring small-scale and artisanal mining operations.

Through the implementation of this methodology, an analysis of different scenarios has been performed. This analysis provides a better understanding of the real conditions of small-scale and artisanal mining operations and helps develop better alternatives for formalization. To achieve this, it is important to form a team of professionals who are involved in solving this problem and who can carry out the corresponding work of onsite formalization.

Before applying the Six Sigma methodology, the numbers of technical files approved, seen, and pending (indicating the progress made on formalization) in 2018 were 6, 93, and 3, respectively. By applying the Six Sigma methodology, the estimated results for the number of files were 678, 320, and 356, respectively.

It is therefore concluded that to improve the formalization process in the Ancash Region, decentralized campaigns should be developed in five zones of the region, strategically grouping them by provinces for greater ease and accessibility. It would be beneficial for the region as it would advance sustainable development.

A total of 11 miners were formalized in 2017 and 6 in 2018 through the comprehensive process in the Ancash Region. It is estimated that with the application of Six Sigma and the public management model, 320 miners would be formalized by 2019.

It was determined that in the mining formalization process, the performance of the document evaluation process was 49.17% in 2018. The results of the study estimate performance to improve to 77.29% in 2019.

The research methodology must be improved as the model does not consider illegal mining activities, which occur in restricted areas or natural reserves.

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Design and Implementation of Online Law Consultation System in Higher Vocational Colleges

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Abstract. With the arrival of the 5G mobile Internet era, people are accustomed to using the network to look up data and obtain information. In the era of administering the country in accordance with the law, colleges and universities, as the main position of education and the most trusted organization of students, have the obligation and responsibility to provide students with learning opportunities and platforms. Colleges and universities should use convenient modern computer technology and advanced network equipment to extend the traditional counselor hodgepodge to professional cyberspace, provide students with legal consulting services independent of time and space, and gradually develop and research the network legal advisory service system that suitable for school characteristics, opens up a good development path for the improvement of school student work and provides a new model and service platform for school information construction.

Keywords: Law · Consultation system · Module · Students in higher vocational colleges

1 Introduction

With the rapid development of economy and society, the mobile Internet has occupied all aspects of college life, the life pace of college students is also accelerating, and competition is becoming increasingly fierce. Meanwhile, the legal issues that have arisen are gradually disturbing the normal life of college students. However, higher vocational colleges do not have a special law major or a legal aid agency, so it is necessary to develop a network platform for legal consultation [1, 2].

The overprotection of the contemporary college students' parents and the skill education of higher vocational colleges make these students lack of comprehensive ability to adapt to the society and relatively weak ability to cope with emergencies. Most of the students in higher vocational colleges come from rural areas, so they have little chance to contact with legal knowledge. As a result, after entering college, they often make mistakes in self-protection when they are in the face of online loans, brushing, theft, online shopping, gambling etc. Their most direct recourse is the counselor. However, the counselor's major is diverse, so most of them cannot give students professional legal advice or help them timely, which will bring the loss of

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economic benefits and seriously affect students' studies. If the college students can be guided correctly through the network, this will solve many problems, because college students can be free in the network, administrators with professional legal knowledge can also give corresponding advice or correct guidance [3, 4]. The Fig. 1 is the functional demand survey designed by a law consultation system in a higher vocational college.

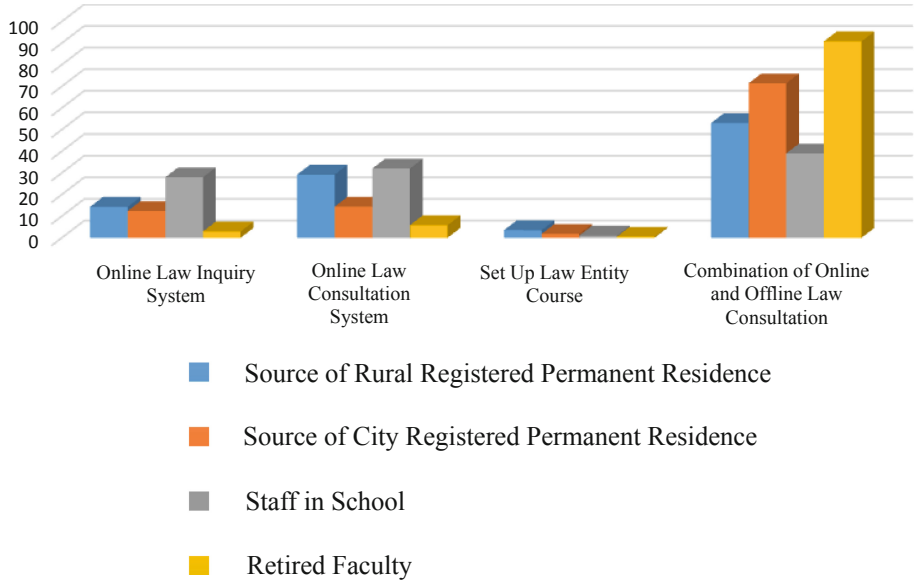

Fig. 1. The functional demand survey chart designed by a law consultation system in a higher vocational college.

2 Important Implementation Functions of System

In the stage of system requirements analysis, we need to make clear what the system "does" firstly, so as to form the logical model of the target system. Now I'm going to build a physical model about "how to do" of the system. The most important part of the general design of the system is the modularization of the system. Modularization refers to the process of dividing a software system into several modules from top to bottom when solving a complex problem. Each module completes a specific function, and all modules are organized in a certain way to become a whole to complete the functions required by the whole system. The system is divided into several modules, in order to reduce the complexity of software system and improve the readability and maintainability, but the division of modules should not be arbitrary and should be kept as independent as possible. In other words, each module only completes the independent sub-functions required by the system, and has the least connection with other modules and simple interface, that is to say, try to achieve high cohesion and low coupling,

improve the independence of the module, and lay the foundation for the design of high-quality software structure. In the general design of the system, the structured design is adopted, which is based on the data flow diagram generated in the stage of demand analysis, and is mapped into the software structure according to certain steps. First, the whole system is divided into several small problems, small modules. Then, further subdivide the modules and add details.

3 Functional Module Division of Foreground of Law Consultation System

(1) System Announcement
The function of this module is to display the latest announcement information of this website. The system adds announcement information in the background and displays it in the corresponding position in the foreground. Announce the latest judicial interpretation and guiding cases, so that the readers can pay attention to the information announced in the first time.

(2) User Login
This module is the entrance to the background management of this site. Users can log in the law consultation system at any time to check the relevant legal content they need by registering the user name and password and authenticating the system.

(3) Friendship links
The friendship link module is used to switch between the law consultation system and other professional websites. This system includes some similar or related websites for friendship links, browsing name can facilitate the students in need to switch to another website in the fastest time. For example: Magic of PKU.

(4) Articles in the Station
On-site graphic is the basic function of the law consultation system. The legal content of this system is classified by categories. The main categories are civil law, criminal law, civil action, criminal action, economic law, and administrative law etc. The universal concerned laws of all the students such as “Marriage Law”, “Law of Succession “, “Company Law”, “Road Traffic Safety Management Law”, “Civil Servants Law” are classified to achieve the purpose of convenient browsing for college students.

(5) Article Search
Users can search by keywords and the names of laws and regulations on the site. Users can search according to the content they are interested in, and quickly locate the articles they are interested in. The article search in this system supports the function of fuzzy query.

(6) Message Function
Users can send comments on this site or some related information to the administrator by leaving a message.

(7) Online Consultation Function
For students who need individual consultation, the system provides relevant advice and suggestions online, write legal documents on behalf of them, and recommend legal aid or law firms and lawyers.

4 Functional Module Division of Background of Law Consultation System

(1) User Management Module
The user management module is mainly to manage the functions of registered users, it can add and delete administrators, audit users, and help users maintain login passwords.

(2) Website Content Management
This module is the focus of background management of the station, used to manage the content of articles, announcements, message information and online consultation. The management of the law content of this website can be completed through each sub module of Website Content Management Module, such as adding articles, deleting articles, adding and deleting illegal message information, etc.

(3) Friendship Links Management
This module can complete the function of our website's friendship links, it can add and delete friendship links.

(4) Activity Links Management
Administrators and super administrators can add and delete active links, active links are also used to link to other websites, but this link is coming out as a mobile window. It can attract more users' attention.

5 B/S and C/S

C/S is the client/server structure and a well-known software system architecture. By rationally assigning tasks to the client and server, the system's communication overhead is reduced, and subdivision can be fully utilized Advantages of the hardware environment. Early software systems used this as the preferred design standard.

B/S structure, namely Browser/Server, is a change or improvement of C/S structure with the rise of Internet technology. Under this structure, the user interface is completely implemented through the WWW browser, and part of the transaction logic is implemented on the front end, but the main transaction logic is implemented on the server side, forming a so-called 3-tier structure.

The B/S structure mainly uses the continuously mature WWW browser technology, combined with multiple VBscript Javascript languages and ActiveX technologies of the browser, using a universal browser to achieve the original need for complex and dedicated software Powerful function and save development cost, it is a brand-new software system construction technology.

Client/Server is based on LAN. Browser/Server is based on WAN. The difference between C/S and B/S is as follows:

(1) C/S is generally built on a dedicated network, a small-scale network environment, and LANs provide connection and data exchange services through dedicated servers. B/S is built on a wide area network. It does not need to be a special network hardware environment, such as telephone Internet access, rental equipment, and information management. It has a stronger adaptability than C/S, and generally only requires an operating system and a browser.
(2) C/S is generally targeted at a relatively fixed user group, and has strong control over information security. Generally, the highly confidential information system adopts C/S structure, which can be published through B/S. B/S is built on a wide area network. It has relatively weak control over security and is targeted at an unknown user group.
(3) C/S programs can pay more attention to processes, can perform multi-level verification of permissions, and can give less consideration to the speed of the system. The multiple considerations of B/S for security and access speed are based on the need for more optimization. It has higher requirements than C/S. The program architecture of the B/S structure is a development trend.
(4) C/S programs can inevitably be considered as a whole, and the reuse of components is not as good as the reuse of components under B/S requirements. The multiple structures of B/S pairs require relatively independent functions of the components. They can be reused relatively well.

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Service Model Under the Lean and Change Management Approaches to Reduce Delivery Times and Optimize the Quality of Processes in a Company in the Metal-Mechanic Sector

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Abstract. A large part of the problems with regard to delivery times and quality of processes at Arnao Industrial Radiators are due to high maintenance times and undefined working methods. Thus, the company seeks to standardize production processes and train its personnel. The company gave an opportunity to resolve these issues to students who together with the company's personnel sought to implement a set of improvements and reduce the activities that did not add value to the service. In the investigation, in which the causes affecting the areas were analyzed, a lack of organization, poor cleanliness, an inadequate use of tools for inspections, polluted material, reprocesses, and non-conforming material in unassigned areas were identified as factors that put the service at risk and the quality level of the plant in doubt. Therefore, the client requested immediate corrective actions; thus, the main purpose of this project was to reduce delivery time and optimize the quality of the processes.

Keywords: Service model · Metal-mechanic · Lean · Change management

1 Introduction

The metal-mechanic industry is one of the most dynamic sectors of the Peruvian economy [1]. In macroeconomic terms, it is expected to grow by more than 6% in 2019, which is associated to the growth of the construction and mining sectors among others. According to information from PRODUCE [2], 45,000 formal companies operate in the metal-mechanic sector of which 98.7% (44,918) are SMEs and 1.3% (297) are medium and large enterprises.

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In addition, by the end of 2015, the GDP of the mining and hydrocarbons sector had grown by 22.36% year-on-year, and so far this year, the GDP of this sector has expanded by 9.27%, which is a beneficial indicator for companies in the metal-mechanic sector. However, complying with the requirements based on the duration of mining projects is complicated because the corresponding companies have to manage their resources more efficiently and, at the same time, seek to be sustainable even when external factors such as fluctuations in the price of metals may affect companies in this area [3].

2 State of the Art

2.1 Service Model

There are currently several service models for the metal-mechanic sector that focus on improving the service provided to the customer. The analysis for the implementation of the model will be based on the characteristics and types of demand typical of the industrial sector under the customer relationship management (CRM) model [2].

The models are generated from a plan of continuous improvement of productivity and quality in the SMEs of the metal-mechanic sector to help entrepreneurs develop innovative and constant activities according to the market and technological changes [3–5]. The solution provided measures the level of performance, which makes it possible to know behavior quantitatively and is the result of a mixed approach with a non-experimental methodology, the design of which is transectional. The purpose is to define the different parts of the SCOR model for SMEs in the metalworking sector in order to identify the supply chain of the categories of each process [6].

The relevance of SMEs demands that the new generation of projects should seek to strengthen these types of enterprises, making it necessary to evaluate and improve their quality management through service models in order to find coherence within the case to be studied [7].

2.2 Lean Manufacturing and Change Management

Any continuous improvement process must promote working conditions to be presented in such a way that delays, operating losses, or any failure are reduced so that the use of resources is closer to the optimal level [8].

For this, measurements of the proposed system were made so as to facilitate the operation, handling of work routines, and environment and to raise the motivation of everyone in the company on the basis of lean manufacturing and change management tools.

3 Contribution

3.1 Proposed Model

The proposed method has four phases and aims to optimize the quality of processes in SMEs in the metal-mechanic sector, reducing cycle times by eliminating bottlenecks and therefore increasing the capacity of the service they provide.

Comparing this model with others, it can be seen that it includes an initial sensitization through the use of change management to avoid problems in the implementation of lean tools (Fig. 1).

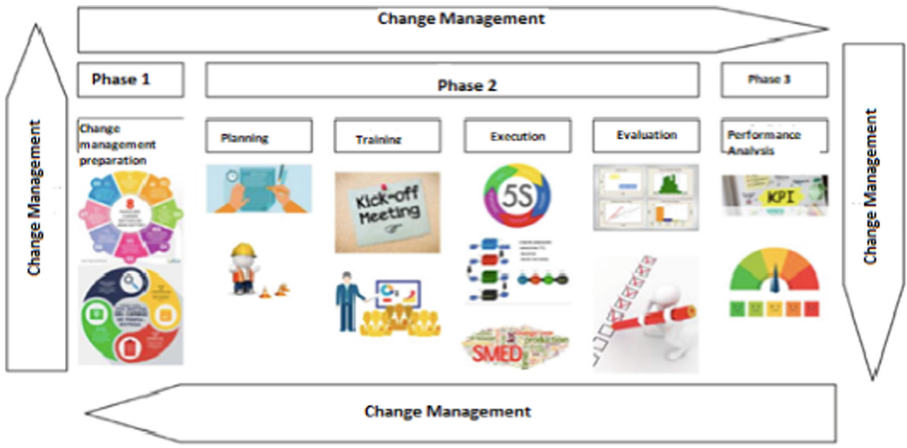

Fig. 1. Proposed model

Phase 1. Change management: Change management is a structured orientation for managing change aspects related to people and the organization. Thus, it seeks to facilitate successful implementation of transformation processes, which involves working with and for people in the acceptance and assimilation of changes and in the reduction of resistance.

Phase 2

(a) Plan: The first stage starts with planning the design of the project. For this, it is essential to identify the activities involved throughout the production process and to collect the data evaluated during the analysis of the current situation of the company.
(b) Training: In this stage, we guide the human resource involved starting with the project leaders, who are shown in the logs presented throughout the period in order to develop the best strategy to be implemented through engineering tools that allow us to address the problems that are identified.
(c) Execution: In this stage the methodologies that have been previously selected to resolve the problems that are identified will be applied.

- 5s: 5S is a tool created to eliminate inefficiencies in processes, especially in repetitive or chain activities.
- Line balance: This tool starts with the selection of the processes to be evaluated in the initial search for sequential relationships by activity and work area.

(d) Evaluation: In this last stage, it is indicated that the project is focused on the constant improvement of its processes so it can move onto the final stage; this is specifically where the necessary changes will be developed to raise errors and eliminate any non-compliance events detected.

Phase 3. Performance Analysis: This phase seeks to evaluate what has been implemented through projected control indicators focused on continuous improvement and investment savings in time and money. With the objective of economically validating the project and for decision making, each of the engineering tools developed will be improved and corrected.

3.2 Proposed Method

To implement the method in a perfect manner, a step-by-step implementation guide was prepared (Fig. 2).

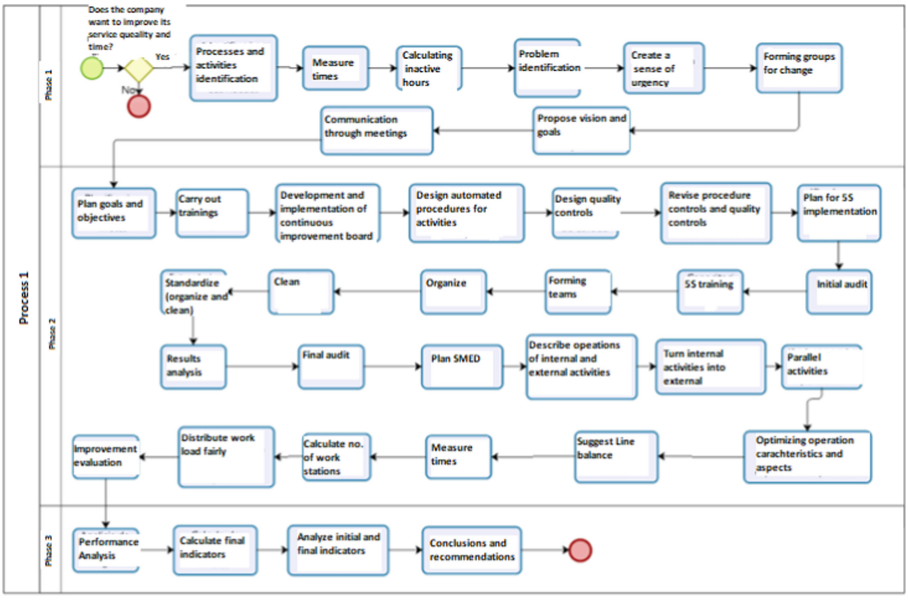

Fig. 2. Proposed method

3.3 Indicators

Attendance Percentage. This indicator shows the percentage of attendance at meetings and trainings.

$$\frac{No.\ of\ attended\ sessions}{Total\ sessions} \tag{1}$$

Percentage of Compliance with Commitments. It is the percentage of compliance over the scheduled time.

$$\frac{Scheduled\ time}{Current\ time\ average} \tag{2}$$

On-Time Delivery Percentages. It is the percentage of orders delivered on time over total deliveries.

$$\frac{No.\ of\ orders\ delivered\ on\ time}{Total\ scheduled\ orders} \tag{3}$$

Efficiency. This indicator shows the cycle time efficiency in relation to costs.

$$\frac{Results\ achieved}{Total\ cost} \times Time\ spent$$

$$\frac{Previous\ result}{Forecasted\ cost} \times Forecasted\ time \tag{4}$$

4 Validation

The case study is based on the manufacture and maintenance of heat exchangers of a Peruvian company, Radiadores Arnao Industrial. It provides technical maintenance service, manufacturing, and basic services for different types of products. In order to better understand the business and the sales behavior of Arnao Industrial Radiators SAC, for the present analysis, it was decided to take a sample of the most requested product with which the maintenance and manufacturing service is provided, which in turn represents the highest income for the company. The business line grossing the most income for the company is the technical service with its most representative line, MESABI (Radiators with independent tubes for mining trucks), in its different models.

Implementation is carried out in three phases:

PHASE 1: Change Management. It was necessary to promote change management, to avoid reluctance on the part of operators. For this, we will base the work on Kotter's eight steps: (1) Create a sense of urgency, (2) Form the team for change, (3) Create a vision, (4) Communicating the vision, (5) Overcome obstacles, (6) Ensure short-term success, (7) Grow on the basic of the change made, (8) Fix the culture change.

PHASE 2: Pilot Plan. We have the engineering tools that will allow us to mitigate or reduce the problems found. In this phase, it is necessary to develop the start-up of each of the continuous improvement tools with the aim of reducing preparation and processing times, as well as improving the quality of MESABI heavy machinery radiator maintenance service.

The aim is, then, to detail the development, execution, and monitoring of improvement activities in accordance with the scheduled dates with evidence and indicators evaluated in the process.

- It started with the signature of the acceptance report of the pilot plan, where the proposals were evaluated to counteract the complaints and reasons for rejecting the product with higher %, through the continuous improvement board.
- Current processes were evaluated, opportunities for improvement were raised, visual inspection training was provided, and quality controls on penetrating dyes and paint ink were designed.
- Current processes were evaluated, opportunities for improvement were raised, training in the use of pressure gauges was provided, and quality controls in hydrostatic tests were designed.
- Current processes were evaluated, opportunities for improvement were raised, training in the use of torque meters was provided, and quality controls on bolt torques were designed.
- In accordance with the research project, classification, organization, cleanliness, standardization, and discipline were implemented.

PHASE 3: Follow-Up and Measurement. According to the final result of the pilot plan implemented with respect to the separation of external and internal activities, conversion processes, elimination of unnecessary activities, and establishment of parallel activities, total time savings of 156 min was achieved for the task of disassembling and washing pipes and 126 min for the task of sanding and painting components. At the same time, the 5S philosophy achieved an impact of 73.32% in the areas of disassembly, sandblasting, assembly, and hydrostatic tests after being implemented in the company. As for the line balance tool, it was able to improve line efficiency by 26% with respect to the initial efficiency of 21% (Table 1).

Table 1. Results

	Activities				Total	
	External		Internal			
	1	2	1	2	1	2
Current time	29.77	43.2	214.02	216	246	288
Separation of activities	12.54	22.05	77.45	140	90	162
Total saving	17.23	21.15	136.56	76.1	156	126

5 Conclusions

Failures in deliveries have two causes: delays in the process of maintenance and the low quality of the product, both in-process and final; we worked on solving 86% of the problem.

Operators' reluctance to change is a critical factor that can affect the viability of the model since it will prevent compliance with 100% of the project.

The proposal presents a model that helps decrease the time of preparation of machines and operation times and finds the number of operators necessary for each work station, for the purpose of reducing the cycle time of the maintenance service.

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Production Management Model for Reducing Product Development Waiting Time by Applying Lean Manufacturing Model for SME Exporters in the Textile Sector

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Abstract. Small and medium-sized enterprises (SMEs) in the textile sector have decreased their overseas sales in recent years due to noncompliance in their deliveries, waste accumulation caused by reprocessing, defects in merchandize, and lack of appropriate foreign language communication skills; these issues have surfaced due to lack of knowledge and mastery over techniques and tools that optimize processes, reduce waste, and help achieve competitive goals set by SMEs while competing in the foreign markets. To overcome these shortcomings, a production process management model is presented in this study; this model showcases that 5s tools of the lean manufacturing model and process standardization can aid in restructuring current processes and can create an optimal process, facilitating a 20% reduction in the excessive work time on the basis of average foreign market standard and help in meeting the established goals.

Keywords: Product development · Lean manufacturing model · Lead time · Model 5s · Textile sector

1 Introduction

The textile industry is one of the most important sources for the Peruvian economy. According to the Association of Exporters (ADEX, in the Spanish acronym), this industry consists of 31.53% of the Peruvian exports, of which 2.61% is represented by the clothing sector [1]. One of the problems that has been affecting this sector is low competitiveness and productivity of the companies, which is reflected in high production costs due to shrinkage and excessive lead time [2].

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To overcome this shortcoming, a production management model is thus proposed; this model aids in analyzing critical processes and methods that are currently being employed; moreover, the application of lean manufacturing tools (5s and standardization) proposed in this research improves delivery time, reduces lead time, increases the quantity of products manufactured, and improves product quality. With these characteristics, it is expected that the Peruvian clothing exporting small and medium-sized enterprises (SMEs) will attract more foreign customer base.

2 State of the Art

Competitiveness in the Current Market. Manufacturing products with greater added value and being competitive are aspects of critical importance in the business world [3]. According to Industrial Vision [4], one of the most successful tools for reducing waste is lean manufacturing. Felizzola and Luna [5] affirm that the most used tools of this methodology are JIT, 5S, Kanban, SMED, Total Productive Maintenance, Value Stream Mapping, and Poka Yokes. According to Helleno and Moraes [6], lean manufacturing and value stream mapping (VSM) have been widely employed to develop waste-free manufacturing processes in the production flow.

Lean Manufacturing in the Textile Sector. Transforming a traditional style company for it to operate under the lean methodology involves a series of challenges that include changing the culture of the organization and developing strong relationships with suppliers and consumers [7].

Lean manufacturing can be defined as a systematic approach to identify and eliminate waste through continuous improvement [8]. Contrastingly, VSM [9] is the process of mapping the material and information. The 5s tool involves a systematic application of order and cleanliness in the workplace [10]. Owing to its simplicity and effectiveness, it is suggested that this technique should be the first lean technique to be implemented because it produces tangible results over a short period [11].

3 Contribution

The model proposed in the study was divided into three phases, namely, analysis of the current situation of companies in the textile sector; design and execution, which seek to implement the 5s and standardization tools of product design processes to reduce excessive lead time among exporting SMEs in the clothing sector in Peru (see Fig. 1).

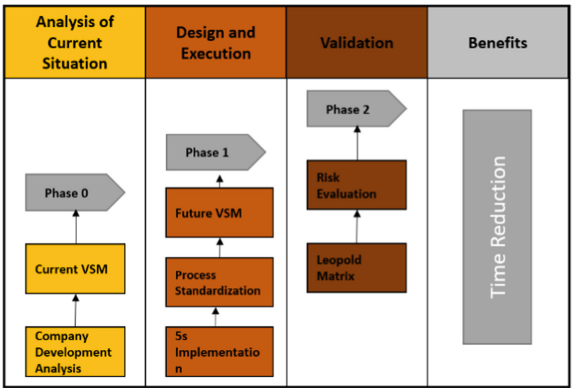

Fig. 1. Model proposed

3.1 Phase 0

Development of a Company Analysis. Companies in the textile and clothing industry, mainly companies exporting clothing items, in their effort to remain competitive in the market, usually consist of two aspects, namely, "fast deliveries" and "on-time deliveries", which basically makeup the so-called time based competition [12, 13].

Current VSM. As detailed in the VSM (see Fig. 3) the total cycle time for the development of a sample is 7 days, and the lead time is 23 days. The average number of versions necessary for the approval of a sample is 2–4 versions before final approval by the customer. The alarming thing is that within the 23 days lead time, 6 days are spent between the elaboration process of technical datasheets and sample manufacturing; this 6-day period consists of 2 days for production wait and 4 days for reprocessing (see Table 1).

Table 1. Summary of waste identified

VSM in days	Processes	Excess days	Reason
6 days	Technical datasheet sample preparation	4 days	Reprocess
4 days	Customer's response and delivery	3 days	Late response from customer
	Pattern preparation	2 days	Design complexities
	Pattern adjustment		Wrong dimensions
	Sample manufacturing		Outdated equipment
			Inexperienced personnel

3.2 Phase 1

5S Implementation. One of the proposals of the model is to use the 5s tool of lean manufacturing to fix the current untidiness in the product development area. To this end, a 5s manual is prepared. In this case, the goal is to restructure the product development field in exporting SMEs in the textile sector using the 5S methodology and convey it to the entire sector and personnel in the field.

To develop the manual, a manual codification was first established to set a sequence and follow a structural order. It also indicates what is expected to be done if there are modifications to be made and ways in which the manual could be updated. It includes several procedures and methods that are listed below:

1S: Sort. In this stage, necessary and unnecessary objects are sorted, and their treatment is determined. This procedure seeks to eliminate and preserve objects.
2S: Set in Order. There is a procedure for the treatment of necessary objects within the work environment, in which a fixed and adequate location is assigned for the tools employed in the area.
3S. Shine. The product development area has a table of cleaning tasks assigned to each employee of the area.
4S: Standardize. Unnecessary objects are labeled for quick identification and relocated outside the product development area.
5S: Sustain. A meeting schedule is established to review the progress of the 5S implementation.

Process Standardization. The second proposal consists of standardizing the elaboration process of a sample within the product development area. The standardization proposal model suggests delivering the following.

- Sample validation method by processes
- Forms of technical datasheets with their respective instructions for use
- Management technical datasheet procedure (storage, update, etc.).
- English–Spanish textile dictionary

4 Validation

This section presents an approach on the basis of a case study of a small textile exporter located in Breña, Lima, Peru. It manufactures and trades cotton knitted clothing for women.

4.1 Current Situation

After reviewing the information and identifying the data through surveys and interviews, it can be concluded that 40.48% of the companies surveyed present "reprocessing" as the main factor of waste generating delays in the companies, followed by downtime (30.95%), and defects (28.75).

Was concluded that 23.81% of the companies surveyed have the problem of misinterpreting their technical datasheets. In addition, 19.05% of the companies mentioned that their main problem is working with an outdated version of the technical datasheet.

4.2 5S Implementation

Before the 5S implementation, a training session or a presentation about the 5S tool should be conducted. This training may be facilitated by a consultancy firm or by an expert. It is important to consider that the topics of the 5S tool presentation should be raised by the company itself, and they should explain the procedures, methods, and/or instructions of the manual. In addition, it should follow the proposed model of the 5S implementation (see Fig. 2).

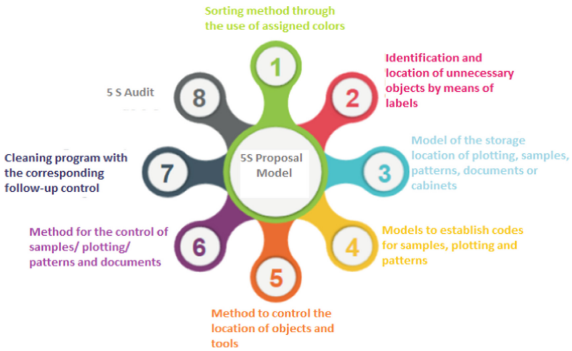

Fig. 2. 5S proposal model

4.3 Standardization

At this stage, the "management of technical datasheets" procedure is used, which details how technical datasheets will be updated, how versions change, etc.

Further, patterns, prototype development, and the adjustment of patterns were prepared. Before continuing with the definition of specifications in the technical datasheet for each process (cutting, washing, sewing, dyeing, and finishing), a English–Spanish textile dictionary is used to translate some terms defined by the customer so that they are presented in Spanish to the operators in the production area.

4.4 Risk Assessment and Leopold Matrix

The score obtained for the 5S proposal in the magnitude factor is 25 points, i.e., the 5S model is 56% beneficial with respect to the optimal value. The importance factor scored 31 points, i.e., the evaluated impacts have an average importance of approximately 68% with respect to the optimum value. For the standardization proposal, a score of 28 points was obtained for the magnitude factor, which represents 63% of the maximum

value, i.e., the standardization model is beneficial for exporting SMEs. The importance factor reflected a score of 33 points, that is to say, the evaluated impacts present an average importance and represent 73% of the optimal score.

On the contrary, to calculate the total impact for each proposal, an average of the values of the magnitudes and the average of the values of the importance of all the aspects evaluated was calculated. After this, the result of both was obtained, and the following outcome was revealed: the proposal with the greatest positive impact on stakeholders is standardization with 54% and 5S 46%.

In the case of SMEs, the most relevant factor positively affected by the implementation of the 5S is increase in productivity. Moreover, the work environment and the workload within the product development area workstation is positively affected in case of the personnel.

4.5 Results

The results obtained after implementing the model in the company are represented in the following (see Table 2).

Table 2. Implementation results

Indicator	Results before implementation	Results after implementation	Improvement
Lead time	23 days	18 days	5-day reduction
% accepted samples	70%	90%	20% increase
% rejected samples	30%	10%	20% reduction

5 Conclusion

The product development process has an excess lead time of 9 days, as companies in Peru have a lead time of 23–28 days, and the standard is 15–18 days. VSM identifies the following: reprocesses (40.48%), waiting (30.95%), and defects (28.75%).

Waste is mainly caused by the misinterpretation of the technical datasheet (23.8%) and the use of an outdated version of the technical datasheet (17.9%). The critical subprocesses for preparing a sample are found between the elaboration of the technical datasheet and the actual preparation of the sample (17.9%).

With the 5S and standardization proposals, the lead time for the elaboration of a sample is reduced from 23 days to 18 days (4 days would be reduced because of reprocesses), and 1 additional day of the cycle time is considered, which is currently 7 days and would be reduced to 6 days. Thus, lead time is reduced by 22%, and reprocesses are cut by 67%. The 5S proposal has a positive impact on SME owners and personnel, as it increases productivity, improves work environment, and reduces the workload.

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Construction of Law Network Courses in Higher Vocational Colleges

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Abstract. The rapid development of 5G mobile networks in the new era is also a new revolution for the education industry. The gradual improvement of online courses provides the key time and opportunity for higher vocational students to improve their legal literacy. In order to allow students to make the most effective legal knowledge storage in the shortest time, in the construction of online courses, we should always adhere to the student-centered, scientifically plan the content and chapter design of online courses, integrate the current legal textbooks, and combine the characteristics and needs of higher vocational students to keep abreast of social life and work needs, constantly update the online courses, reform the education model, and actively cultivate basic legal literacy for students to integrate into social life, effectively improve students' practical ability to combine practical learning with practical application.

Keywords: 5G · Law network courses · Principles · Development

1 Introduction

With the advancement of administering the country in accordance with the law, people are paying more and more attention to the protection of their rights and interests [1]. With the advent of the 5G mobile Internet era, the number of students using the Internet to acquire knowledge has gradually increased, so the transformation of traditional education to Internet education has become an inevitable trend [2]. Higher vocational education is limited by time and talent training programs. Law courses that college students need to understand urgently such as life-related "Consumer Rights Protection Law", "Company Law", "Administrative Law", "Marriage Law", etc., traditional school courses cannot covers, but network courses emerges and can exactly meet the needs of students and make up for the deficiencies of traditional courses. Therefore, the development of high-quality legal courses suitable for higher vocational students has become an important topic in the development of vocational education [3, 4].

With the rapid development of the information society, how should vocational colleges with the responsibility of cultivating new high-quality skilled personnel change? How to cultivate new talents with legal literacy and craftsman spirit that meet the needs of contemporary society? How to meet the needs of students for legal knowledge? The use of network courses to realize modernize education in the information society is a new teaching idea, teaching method, and teaching means, and it is a favorable supplement for teaching construction in higher vocational colleges. But the

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construction of law network courses is more important, without high-quality network courses, the actual needs of students cannot be realized. To this end, colleges and universities should correctly face the opportunities and challenges of the information society, attach importance to the construction of network courses, and solidly promote the integrated reform of teaching thinking, teaching content, curriculum system, teaching methods and teaching means, and strive to create new higher education situation.

2 Principles of Higher Vocational Law Network Courses Development

From the perspective of the general needs of college students in a certain period of time, when designing network courses, we must adhere to the focus of learners. In order to clarify the actual needs of students, a questionnaire survey of students from Wuhan Polytechnic is taken as an example to briefly explain. Figure 1 is shape diagram of a questionnaire survey of students from Wuhan Polytechnic, China.

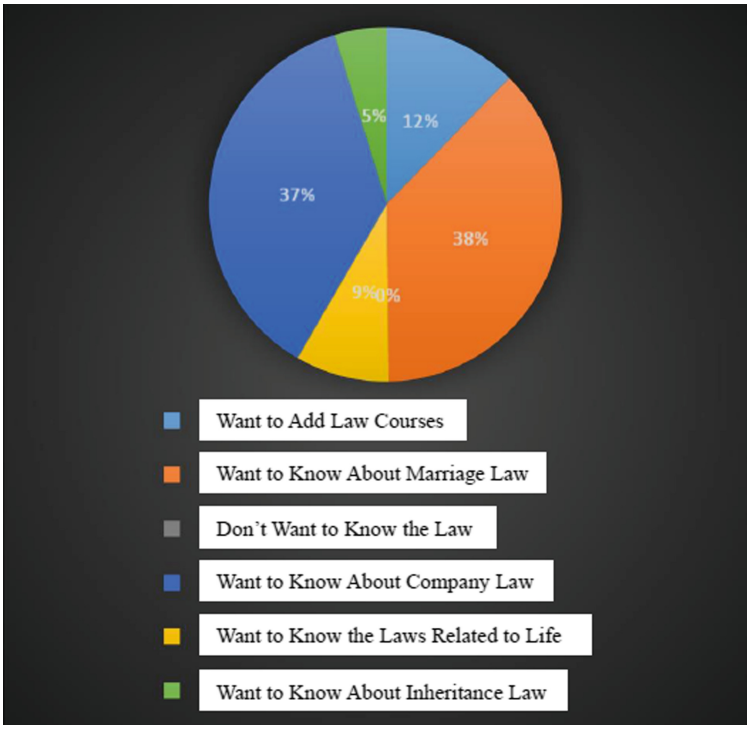

Fig. 1. Shape diagram of a questionnaire survey of students from Wuhan Polytechnic.

According to our survey, I believe that the construction of law network courses suitable for higher vocational students should follow the following principles:

The principle of openness. It refers to the design of law network courses that should have multiple learning starting points, multiple learning paths, and multiple learning evaluations. Because of the different starting points and backgrounds of students in network courses, we must adapt to these changes and characteristics in instructional design. The complexity and diversity of things should be emphasized. Understanding of things or mastering of knowledge should start from multiple levels and angles. Different learning starting points must be set for learners at different levels to achieve step-by-step guidance and explanation, so that each student can understand and use it.

Top-down principle. It means that the content of the network course is best developed from the constitution to specific departmental laws, that is, first to present the learner's fundamental law, the Constitution, and bring them into a more complete legal system of social life. Then, let the learners try to solve the problem according to their own experience, and finally let the learners find relevant laws in the process of trying to solve the problem, learn relevant legal knowledge through the guide of interest, and it is easier to learn and apply relevant, specific knowledge and methods.

The principle of authenticity. Select and use real cases in social life, so that learners can feel the importance of understanding legal knowledge to the protection of rights and interests in life in network learning activities. It is necessary to consider the contents and expressions of network courses, teaching scenarios, teaching auxiliary services, support subsystems, teacher-student interaction subsystems, student communication subsystems, and emotional communication subsystems. Through the construction of these real cases, the situational experience of learning is improved, the interest in learning is stimulated, and the situational communication between teachers and students and between students is enhanced, thereby promoting the quality of learning.

3 Design of Law Network Courses

With the continuous development of the People's Republic of China, in order to adapt to economic and social development, our laws will be changed every year. In order to allow students to quickly and effectively learn the legal knowledge they want to learn through our network courses, we should form a professional team, conduct a competitive investigation of the actual needs of college students, and use the platform that matches the school's informatization to upload, adjust and update our courseware in a timely manner, so that more students in need can benefit in time, improve their legal literacy and better serve the community.

Case teaching is one of the most effective teaching methods in law courses and is used widely in classroom teaching. It is very helpful for learners to understand the legislative background of the country, deepen the understanding of relevant legal knowledge and effectively grasp key issues. In the design of law network courses, the case teaching design can be more vivid and flexible than classroom teaching. It can use a variety of transmission technologies, such as teacher's appearance, pictures, sounds, flash animation, etc., which also meets the psychological requirements of students'

learning. In the choice of cases, we must be close to life, using the guiding cases issued by the Supreme People's Court and cases with great social impact, and extend the cases to the teaching content, and ultimately serve the teaching content. At the same time, we provide students with case studies behind each case to deepen the students' understanding and mastery of knowledge points.

Course content design is an important aspect of attracting students to network courses. Each chapter's teaching content is composed of countless knowledge points, and the knowledge points between chapters are also linked. In classroom teaching, teachers will guide students to use divergent thinking ability to review, compare and summarize knowledge points. In network courses without teachers, this learning link or learning method should also be provided for learners. Search is a distinctive feature unique to the Internet, so the "Content Search" column is designed to achieve a non-linear connection between knowledge points. The content search implementation technology of network courses is keyword search. You can search for the knowledge points throughout the course, such as legislative guiding ideology, legal forms, legislative overview, criminal names, crimes, economic legislation, marriage and family systems, and judicial systems. It can also be a search of the specific content of each chapter, or a search of concepts such as a code, a sentence and a crime, a historical person, and so on. With this function, students can not only make conclusion, before and after comparison, but also review at any time.

4 Massive Open Online Courses (MOOCs)

Massive Open Online Courses (MOOCs) are free online courses available for anyone to enroll. Massive Open Online Courses (MOOCs) provide an affordable and flexible way to learn new skills, advance your career and deliver quality educational experiences at scale.

Massive Open Online Courses (MOOCs) in China is an online education platform jointly launched by NetEase and Higher Education Club. It undertakes the national excellent open curriculum tasks of the Ministry of Education, and provides Massive Open Online Courses (MOOCs) of well-known universities in China to the public. Here, everyone who intends to improve themselves can get better higher education for free.

Massive Open Online Courses (MOOCs) has a set of homework assessment systems and assessment methods similar to offline courses. Each course starts on a regular basis, and the entire learning process includes multiple links: watching videos, participating in discussions, submitting assignments, interspersing course questions and ultimate exams.

The courses are managed and operated by the teaching affairs offices of all universities. Colleges and universities create courses and designate teachers responsible for the courses. Teachers make and publish courses. All teachers must be verified by the real name of the college's love course network. The teacher's new production of Massive Open Online Courses (MOOCs) needs 9 links including course selection, knowledge point design, course shooting, recording editing, etc. After the course is

released, the teacher will participate in online tutoring such as forum questions and answers, correct homework, etc., until the end of the course to issue a certificate.

Each course has an assessment standard set by the teacher. When the final score of the student reaches the teacher's assessment score standard, you can obtain a certificate of excellence signed by the host teacher for free, or you can apply for a paper version of the certification certificate. Obtaining a certificate means that the student has met the learning requirements, and the understanding and mastery of the content of the course has met the requirements of the corresponding university. He or she can also proudly write the fact that he passed the course in his resume.

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Lean Six Sigma Operational Assessment Method with a Modified DMA-IC Cycle for Reducing Non-productive Times at Mining SMEs

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Abstract. This paper demonstrates how deployment of the Lean Six Sigma (LSS) methodology within the operational management of small- and medium-sized mining companies (mining SMEs) fosters the development of a new assessment method aimed at reducing non-productive times in one or more operations. However, this study only seeks to implement this methodology in the cleaning, hauling, and transportation stages. Even though Lean and Six Sigma methodologies are different tools, they are often combined to reduce waste, non-value-adding activities, and process variability, with the purpose of reaching the desired operational efficiency levels. The LSS methodology traditionally works with a DMA-IC phase structure (Define, Measure, Analyze, Improve, and Control); however, this study uses a variation thereof adapted in the best way to the Operational Assessment method proposed. This variant deploys the first three phases separately while combining the last two to produce a comprehensive improvement and control plan. This papers provides useful and meaningful information to reveal the maximum value obtained from the implementation of the LSS methodology in the development of this new method, as it not only dispenses an exhaustive diagnosis of the operations assessed but also a quantitative estimate of the potential improvement levels that could be reached if correctly implemented at mining SMEs.

Keywords: Operational Assessment method · Mining SMEs · Lean Six Sigma · Non-productive times

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1 Introduction

In recent decades, the mining industry has been experiencing an unprecedented global expansion owing to growing investment trends within this sector, this growth is more evident in Latin America. In fact, in the last few years, this region has gone to receiving from 10% to more than 25% of the worldwide mining investment, remaining one of the top five most attractive regions for mining investment in the world.

The operation lead times are paramount for improving company performance; however, this is one of the least controllable variables within a process [1, 2]. Hence, as an organizational solution and in attempt to control the time variable, a well-defined hauling and transportation operational management may exert positive effects on process efficiency, company profitability, and operations safety. Therefore, this research project proposes the deployment of a Lean Six Sigma (LSS) Operational Management model aimed at reducing non-productive times in the cleaning, hauling, and transportation stages at mining SMEs.

2 State of the Art

Management Models at Mining or Mining-Related Companies. Methodologies, such as Lean, Six Sigma, BPM, TQM have been continuously implemented as improvement management components in the mining industry [3]. Moreover, as manufacturing methods are being adapted to the mining industry, these methodologies exert greater influence on economic matters and on the applicability of commonly used strategies in the company's tactical, operational, and strategic environments [4–6].

Lean Six Sigma Management for Mining or Mining-Related Operations. Scholars such as Bogacz and Migza have conducted separate studies on the Lean and Six Sigma approaches, however, upon completing their research, both concluded that despite these differences, Lean and Six Sigma complement each other. In fact, their combination creates synergies between them and leads to the philosophy of excellence and improvement [7–9].

3 Contribution

For the development of the proposed assessment structure, the construction improvement process proposed by Tchidi, He, and Li was selected based on the Six Sigma implementation method they used. However, it was necessary to steer their approach to the mining sector and, in particular, to mining SMEs. Moreover, the Lean perspective was added to complete the LSS foundation. The model was also adapted as per the objectives set forth, using the Tenera and Pinto project management improvement model (Fig. 1).

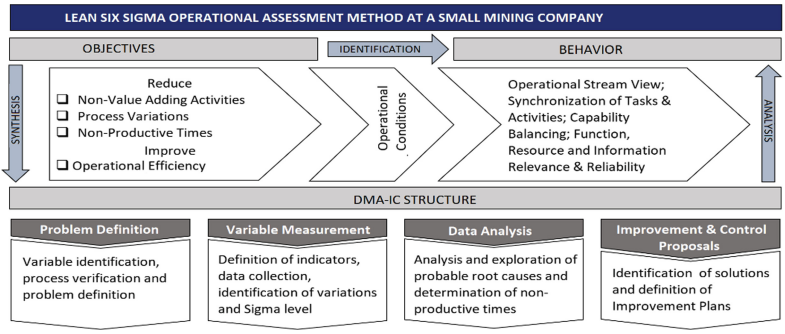

Fig. 1. LSS Operational Assessment

Objectives: Decision-making throughout method deployment will always be linked to the objectives set forth for the application of the LSS methodology and will always depend on operational conditions, which facilitates the development of a method structure and the identification of operation behaviors.

Behavior: Operational behavior is assessed through the different operational factors studied in the assessment structure established for the method, as per the objectives set forth by the methodology.

Structure: The structure of the LSS Operational Assessment method will be based on a continuous improvement approach, which converts this method into an effective management tool for assessing operations management. In turn, it also comprises the following four successive phases:

Problem Definition: This phase defines the current situation exhibited by the process and identifies the corresponding field of improvement in terms of non-productive times.

Variable Measurements: This phase establishes the indicators used to determine operational behavior, and the data collected represent the actual performance of the operation.

Data Analysis: This phase performs an exhaustive examination of field data to identify the root causes for non-productive times.

Improvement and Control Proposals: Finally, an improvement and control plan is made on the basis of the assessment results.

3.1 Proposed Methodology

The development of the methodology must be explained through a flowchart, which provides an overall view of the operations that may take place at mining SMEs (Fig. 2). It should be noted that in this research project, a variation of the DMA-IC approach was developed, wherein the first three phases (Define–Measure–Analyze) were performed separately, and the last two phases were combined as one (Improve–Control).

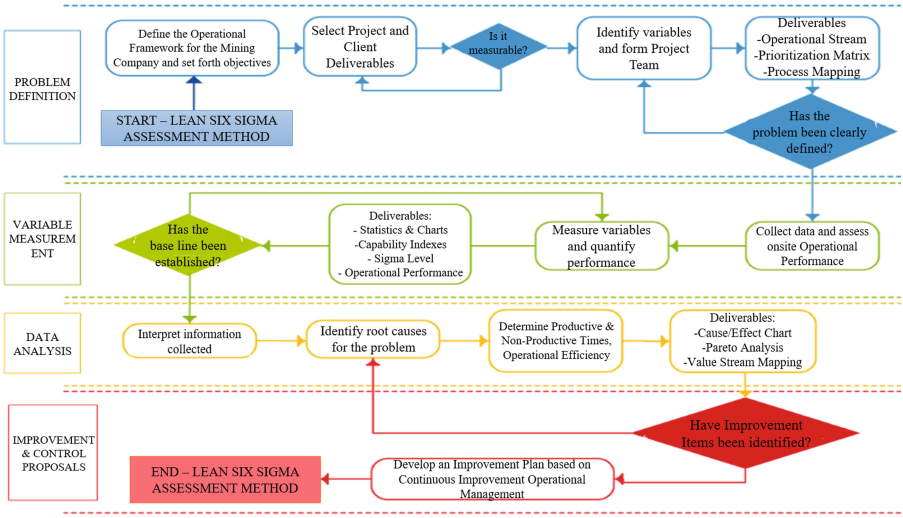

Fig. 2. Operational method methodology

3.2 Indicator View

The indicators used in the Operational Assessment are simplified as follows:

- Process Capability Index (Cp and Cpk): These indicators measure the capability exhibited by a process for operating at an expected level.
- Sigma Level: This indicator measures variation for a specific variable within a set of process data, which corresponds to the number of standard deviations fitting between the process specification limits.
- Operational Efficiency: This indicator measures how productive operations are according to the time they take.

4 Validation

4.1 Case Study

The Operational Assessment method combined with LSS methodology, as described above, was deployed for the cleaning, hauling, and transportation operations at the Canta Mining Unit, located in the district of Huamantanga, province of Canta, department of Lima.

4.2 Method Deployment in the Case Study

Problem Definition. To assess the most critical processes, the Prioritization Matrix divides the operation into the following four segments: from the exploitation site to the mineral ore deposit (T1), from the pithead to the overburden deposit site (T2), from the

ore deposit to the collection site (T3), and from the collection site to the treatment plant (T4). Additionally, the parameters were qualified and quantified into the Prioritization Matrix, where the total score of each segment was determined.

Variable Measurements. In the second phase, the times corresponding to Segments 1 and 3 were sorted into two groups: the first group included times taken during the cleaning and hauling process (Segment 1), and the second group comprised the transportation activities performed between the low-profile dump truck (15 MT) and the backhoe (Segment 3). These times were further subdivided into preparation times, travel times, waiting times, and unloading times, respectively (Figs. 3 and 4).

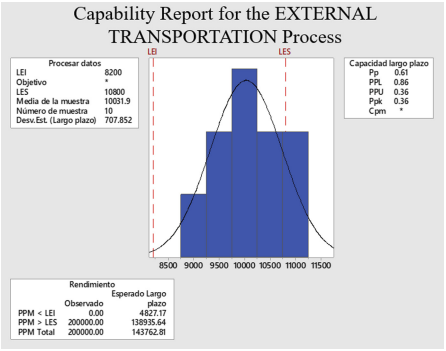

Fig. 3. Capability report for Segment 3

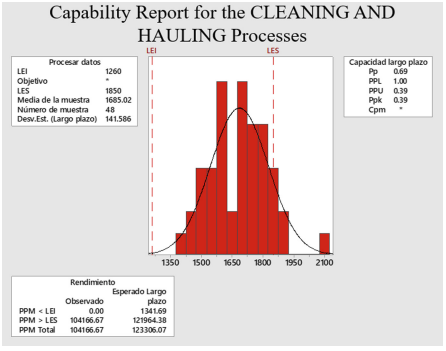

Fig. 4. Capability report for Segment 1

Both capability reports indicate that the processes are not capable of meeting specifications, as some data report outside the upper limit (Pp and Ppk, <1).

Data Analysis. To reach deeper, and to determine the root causes of the delays, the causes identified were segmented and weighted according to the frequency and impact over time through a Pareto diagram, as depicted in Fig. 5.

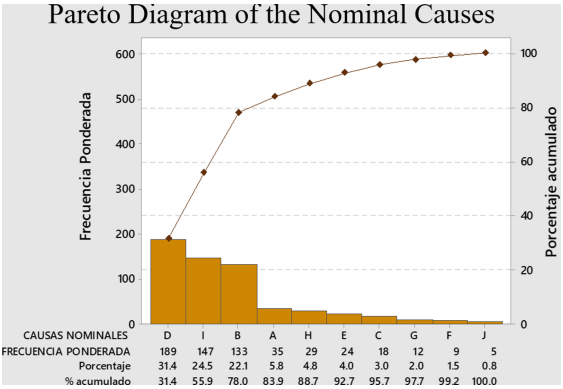

Fig. 5. Pareto diagram of the nominal causes

The nominal causes that exert the greatest impact on non-productive times are bars D, I, and B, corresponding to slowly loading the dump truck, manually loading the dumper, and separating large rocks, respectively. Likewise, the activities and non-productive times for Segments 1 and 3 were classified using Value Stream Mapping, where it is concluded that the guaranteed improvement opportunity for the cleaning and hauling of mineral ore and transportation are 18% and 24%, respectively. Both percentages represent the non-productive times within the process so these activities can be completely removed from the operation.

4.3 Results

- Capability Analysis (Cp and Cpk): In the Process Measurement phase, cleaning and hauling (Segment 1) and the transportation of mineral ore in 15 TM-dump trucks (Segment 3) were identified as relevant activities, obtaining Cp and Cpk values of 0.69 and 0.39, respectively, for Segment 1, and of 0.61 and 0.36, respectively, for Segment 3. However, after making the improvement projections with the proposals described above, the mean Cp and Cpk values for both Segments reach 1.17 and 1.05.
- Sigma Level: In the process assessed, Segments 1 and 3 exhibited Sigma levels of 1.16 and 1.06, respectively. After deploying the improving alternatives proposed, including standardization, documentation, and changes to the hauling and transportation system based on the "Pocket" design, the Sigma Level projected for cleaning and hauling mineral ore increased to 3.16, and, for the transportation process, to 3.48.
- Operational Efficiency: As per the different Value Stream Mappings, if non-productive times are removed, the time spent in cleaning and hauling could be reduced by 18%, while the transportation time would experience a 24% reduction, for an operational efficiency of 82% and 76%, respectively.

5 Conclusions

Through this LSS assessment method, broadly consisting of collecting data and interpreting statistics to identify the root causes of the non-productive times recorded and finally proposing improvement and control alternatives, improvement opportunities have been identified and strategies have been established to foster the development of small and medium-sized mining companies.

Since most SMEs lack a well-defined operations measurement system, they usually require a large number of improvements in terms of efficiently managing their operations. Hence, from a perspective focusing exclusively on this approach, the cleaning, hauling, and transporting processes were assessed at an artisan mining SME, which lead to the development of an action plan.

However, this study ultimately seeks to provide support and guidance to workers and managers at mining SMEs, so that they can deploy this Operational Assessment method in their corresponding companies and improve their operational productivity

levels. Within this context, a LSS framework has been proposed, describing the essential elements of the LSS methodology, as well as the existing relationships among them. Further, the DMA-IC Cycle variant provided has been explicitly designed for assessing mining operations.

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An Analytical Study of Aptitude Tests for Entrance to Architecture Education: A Case of India

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Abstract. One of the many criteria used for the selection of prospective candidates to professional courses all around the world are entrance examinations or aptitude tests. In India, Architecture Education is one of the many preferred professional courses. The national aptitude entrance examinations conducted in India are, the Joint Entrance Examination- Mains (Paper 2) and the National Ability Test for Architecture (NATA). This study, in the above context, focuses upon the analysis of the aptitude and creative aspects of NATA entrance examination, which is used for the selection process of prospective aspirants. Literature study supports the fact that psychometric tests are used for examining various cognitive and scholastic abilities to estimate future success in academic studies in various disciplines. The outcome of the study revealed that there are some more aspects used to evaluate creativity through the works of various psychologists and psychometric tests, which can find favor in the current aptitude tests used for evaluating aptitude required for architecture education.

Keywords: Aptitude and creative aspects · Architecture education · Aptitude entrance examinations · Psychometric tests · Parameters and indicators

1 Introduction

Architecture is one of the most distinctive professional fields in India and globally. Architecture Education involves in developing the aptitude required by the student or candidate for the professional field. Entrance to Architecture Education involves many criteria like academic performance in high school, portfolios, psychometric or scholastic tests, interviews, personal statements, letters of recommendation, special architectural aptitude tests, etc (Goldschmidt and Sebba 2001). The special architectural aptitude tests are considered as an important criterion for admission into architectural institutions. In India, we have two national level entrance examinations for architecture. They are the Joint Entrance Examination – Mains (Paper 2) and the National Ability Test for Architecture (NATA). As applications exceed the number of seats available, screening of applications is done through these entrance exams. These entrance exams are responsible for selecting the right candidates for the profession.

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1.1 Aim

The present study, in the context of the above said need, aims at a limited scope of documentation of similarities and dissimilarities in the selection procedures through a comparison between practices in India and a few other countries taking samples from both the developed world and the developing world. It also focuses upon the second aspect of the need, that is, criteria chosen in the selection process, however, taking case samples from India only. In short, the aims of the study are as follows:

- To find out how assessments of aptitude for architectural education has been happening across the world and compare the same with that in India.
- To find out the aspects of aptitude and creativity being tested in the entrance exams related to admission to Architectural Studies in India.

1.2 Objectives

The Objectives for the study identified are as given below:

1. To define aptitude and conduct a literature survey of past research works explaining different aspects of aptitude & creativity and the currently established modes in which they can be tested.
2. To explore admission procedures/criteria adopted for B.Arch. Program in National and International context.
3. To study the components of one of the two national entrance examinations used for assessment of aptitude at entrance level for architecture studies in India.

2 Methodology Adopted

The methodology consists of three parallel studies (also given in Fig. 1) leading to the matrix which formed the way to analyze the samples for coverage of aspects of aptitude and creativity. The first study includes the revision of historical and current- international and National practices of testing prospective candidates for admission to the undergraduate program. The second parallel study dealt with the aspects that are currently in use for identifying aptitude and creative aspects as identified by Psychologists and early researchers. The third study looked up into the requirements of aptitude especially for architecture education. The outcome of the three studies led to the formation of the matrix that used further to analyze the current entrance examinations. With the help of the indicators, parameters and sub parameters the matrix was developed. Data collection was in the form of 5-year question papers from 2011–2015. There were 400 questions as samples. The questions were finally placed in the group they belong to in the matrix as per their attribute. The frequency of questions appearing in the matrix in a particular parameter and sub parameter gave way to the analysis. The image below shows the methodology used for the current study.

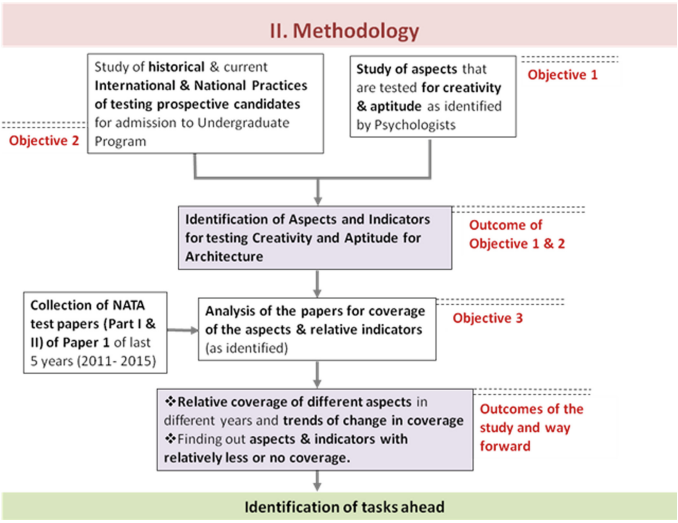

Fig. 1. Methodology of the study

3 Designing the Matrix

3.1 Historical and Current-International and National Practices of Testing Prospective Candidates for Admission to the Undergraduate Program in Architecture

The historical description of admission into schools, since the institutionalization of architectural schools, was done. Three of the earliest avant-garde institutions were taken into consideration for this study. Majority of the western institutions of architecture followed the French Ecole Des Beaux Arts, which was set up in 1819 to cater to the needs of the French aristocrats (Carlhian 1979; Egbert 1980). An alternate model of architectural education was set up in 1920 in Europe, the Bauhaus in Germany, set up in 1919 and the Vkhutemas (Higher State Artistic and Technical workshops) in Russia, in 1920. In both institutions, architecture was a unit alongside other units devoted to arts and crafts.

Assessment of creativity was emphasised by characteristics like fluency, flexibility, originality, elaboration, ideational fluency (Guilford 1967, Hocevar 1979, Batey 2007) by psychologists. A psychological test was used as an assessment tool to evaluate candidate performance not limited to skills and knowledge, abilities, personality traits, attitudes and academic potential (Anastasi 1997). At the same time there are practical contextual skills along with analytical and synthetic skills which account for the aptitude of students (Sternberg 1997).

3.2 International Practices of Testing Prospective Candidates for Admission to UG Program

From literature survey, a list of eight different criteria was extracted from admission processes used by different institutes around the world (Goldschmidt and Sebba 2001). The list of criteria is currently still in use. All schools of architecture follow one or more of the criteria to screen candidates. No school admits applicants without scrutiny. The Table 1 given below gives a short description of the criteria.

Table 1. International practices of testing prospective candidates for admission to UG program

Sr. No.	Admission criteria	Description
1	High school records ...	In terms of CGPA at matriculation & HSSC level
2	Psychometric tests/General scholastic aptitude tests	To examine cognitive & scholastic abilities
3	Special architecture aptitude tests	To test mathematical & spatial abilities
4	Interview	With inclusion of the portfolio of creative/design work
5	Portfolio	To be presented at the time of interview of design work/creative work
6	Essay	To test the semantic ability
7	Statement of Purpose	To study the intent of the student
8	Letters of recommendation	From former or present teachers acquitted with candidate's work

3.3 The Components of Entrance Examinations Used for Assessment of Creativity at Entrance Level for Architecture Studies in India as a National Test Applicable Across States

There are two national level aptitude tests for entrants in architecture. The National Aptitude Test in Architecture (NATA) is conducted by the Council of Architecture, India at national level for admission to 5 year B.Arch. Degree Course at all recognized institutions across India, by Government, Govt. Aided & Unaided schools/colleges of Architecture. The test measures drawing and observation skills, sense of proportion, aesthetic sensitivity and critical thinking ability. The test is in two parts. A paper based drawing test for two hours and computer based online aesthetic sensitivity test.

4 Data Collection

Data collected for analysis was in the form of question papers. The entrance examination question papers of 5 years – 2011–2015 were collected. This paper consists of two parts: Part I and Part II. Part I consists of 30 multiple-choice questions of Mathematics and Part II consists of 50 multiple-choice questions of the Aptitude Test. One fourth mark is deducted for the incorrect answer.

The sample size is given as below:

Part I: 30MCQs × 5 number of papers = 150
Part II: 50MCQs × 5 number of papers = 250
The Total Sample Size: 400 questions (with papers from 2011–2015). Each question was analyzed as per its attribute and placed in the respective head in the matrix.

5 Observations

The observations were recorded in the frequency of questions for listed parameters for the NATA test papers of five years. The same can be seen in the Table 2 given below.

Table 2. Observed frequency of questions for different parameters across years in NATA test paper 2

Psychometric Tests (Parameters)	Intelligence					Analytical Skills					Practical Contextual Skills				
	2011	2012	2013	2014	2015	2011	2012	2013	2014	2015	2011	2012	2013	2014	2015
Behavioural	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Logical	13	12	10	16	0	1	2	5	0	5	0	0	0	0	0
Mathematical	21	21	21	16	21	9	9	9	14	9	0	0	0	0	0
Semantic	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spatial	0	1	0	0	15	36	35	35	34	30	0	0	0	0	0

The results were then converted into relative weight-age as given in the following Table 3.

Table 3. Observed weightage for different parameters across years in the entrance examination (weightage in percentage)

	Intelligence			Analytical		
	Logical	Mathematical	Spatial	Logical	Mathematical	Spatial
2011	16.25	26.25	0	1.25	11.25	45
2012	15	26.25	1.25	2.5	11.25	43.75
2013	12.5	26.25	0	6.25	11.25	43.75
2014	20	20	0	0	17.5	42.5
2015	0	26.25	18.75	6.25	11.25	37.5

6 Analysis

The overall pattern of distribution of components in NATA Test papers was analyzed. It was found that highest weightage is given to the Spatial Component. Medium weightage is given to Mathematical component and then to Logical component.

The contribution of Behavioral and Semantic component is completely absent. Looking at this, Behavioral and Semantic testing needs to be included and accommodated in the tests.

The comparative emphasis laid in NATA Test Paper 2 amongst Logical, Mathematical and Spatial parameters suggests that the mathematical parameter is constant in all the years, whereas the Spatial and Logical components vary over the years. Among the sub parameters, the practical contextual skills are not tested in any of the years. The proportions of Synthetic Intelligence Skills and Analytical skills are unproportionate over the years.

7 Inferences

Looking at this, Behavioral and Semantic testing needs to be included and accommodated in the tests. There is a scope of possible expansion of factors in Behavioral and Semantics domain. The relative importance of different components needs to be researched. Finally, from the study, we also come across the indicators which are tested and which are not tested. The indicators now need to be prioritized in a hierarchical order.

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An Application of Social Network Analysis to Study Interconnection of Courses in Mathematics Education Curriculum

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Abstract. Subject-matter or course content that is selected to be taught and learnt, including its scope and sequence are significantly one of the major components of any qualified curriculum. The objective of this research is to determine the significance of interconnection attributing to achievements by the undergraduate students of the Mathematics Education curriculum based on the Social Network Analysis. 159 online respondents supplied by the graduates during the academic year 2016–2018 are used in the study with results indicating strongly that Teaching Psychology, Graph Theory and Fundamental of Mathematics are reportedly vital courses upon which their contents if mastered properly would encourage and enable interconnection with others. Additionally, Fundamentals of Mathematics, Linear Algebra, and Graph Theory are found to be powerful courses while the Measurement and Evaluation in Learning Mathematics and Actions research in Mathematics combination can influence effect over the whole courses.

Keywords: Social Network Analysis · Student achievement · Courses relationship · Components of a curriculum

1 Introduction

Subject-matter that is selected to be taught and learnt, the scope of the subject-matter and its sequence represent major portions of any curriculum element. Grades being the prime objective represent the final product of any curriculum model. The design of any program of studies is the deliberate organization of the curriculum within a course or classroom and typically contains the knowledge and skills needed by students to succeed and master in order to advance to the next phases or courses of study. Courses are a part of the curriculum intended to facilitate and assist students in acquiring such knowledge and skills [1]. Essentially, as an integral mechanism of the curriculum design leading to qualify the graduate procedure fulfilling the ultimate aspiration of each course having previously predefined [2], curriculum course designing whereby bond among the different classes is coherently established is meticulously crafted with the aim of empowering learners in their abilities to shape their own education through choices [3]. Assessment to follow informs students' progress prior to their graduations, oftentimes from regular data collected when finished courses, does additionally

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contribute to the insight of the curriculum's advance. As a result, exploring the relationship of the courses undertaken along with student performance might potentially be valuable as a key for helping, developing and/or renewing curriculum eventually guiding to the results of qualified graduates with an advance academic success [4]. The trend of considerably linear relationships of accomplishment in studying programs in the curriculum framework and the intellectual effort employing the GPA (the Grade Point Average) of undergraduate students at Suan Sunandha Rajabhat University, Faculty of Science and Technology, is depicted in the following programs of study, namely, the Applied Statistics, Biotechnology, Chemistry, Computer sciences, Food Industry and Services, Informatics-Mathematics, and the Home Economics and Biology program. Social Network Analysis (SNA) is theoretically employed in sociology related studies and inquiries. Based on the network and graph theories, the model is used in analyzing structural patterns in social relations [5]. It is also applied for use in investigating questions involving relational data in the diverse discipline of which some may not be an explicit social network. The SNA technique is suitably qualified especially when communicating the understanding of crucially powerful or influence nodes. Taking into account the SNA method, it is probably justifiable applying SNA to analyze the completion of the course among network construction in the curriculum. The purpose is hence to investigate the relationship of the achievement of the course exhibited by learners studying the mathematics education program at the Faculty of Education considering the following scopes; Articulation and Balance, Continuity, Integration, and the Sequence.

2 Phases of the Experimental Research

2.1 The Data Collection

The preliminary data used this project comes from the result of students' academic reports stored in the student registration system and scholars who graduated from the Mathematics Education program of the Faculty of Education, Suan Sunandha Rajabhat University in Thailand stipulating in the 2016–2018 academic years. The representative sample of 159 registered through the online system are measured.

2.2 Methods

This network analysis tool is capable of creating relevant indicators and it focuses on providing an understanding of the structure, consequences, and determinants of relationships between performers. In other words, it assists in apprehending how relationships are being formed, what sorts of related frameworks do diverge from the building sections of individual relationships between pairs of users and have an effect on these relationships on leaners. The emphasis of connections and appearing architecture being designed by relationships generated the SNA unique and various from other research paradigms which usually place emphasis singly on the facets of users [6]. To evaluate the significant connection among nodes within the graph, measuring the distance between nodes is being considered. Also, there are four methods that are

popular to be used in the assessment of the network analysis as follows: the betweenness, the closeness, the degree centrality, and the eigenvector centrality. The betweenness centrality, based on the shortest path theory, is used to estimate how often a node lies on the minimum distance between o nodes per unit of times. The closeness centrality assesses the closeness connection of a node calculated on their high degree score to all other nodes in the network. The degree centrality acts to indicate the score of the link's number connected with each node. Finally, the eigenvector centrality identifies the nodes' influence depended on the relative of nodes among other nodes within the graph [7]. In this study, nodes are assigned by 43 courses including major courses and Teaching professional courses. Edges are defined by the relationship between the pair of courses and the weights of edges are determined by Pearson's Product-Moment Correlation of achievement of each pair of courses. All essential courses are used to construct a network and each node represents the courses as presented in Table 1. Pearson's Product-Moment Correlation method is suitable for determining the relative, the strength of the linear relationship and the exists of an association between the two variables. The connection among nodes is plentifully considered the primary achievement of undergraduate students' academics.

3 Finding

The achievement of the course network being weighted included of 43 nodes and 511 edges constructing from a positive value derived from the significant positive correlation between achievement with each pair of course at 0.01. According to Ergün, Usluel, the average network density value of density measurement of this research was 56.5% that informed the middle-level value of density measurement [5]. The power of nodes based on their interconnection is measured by the Betweenness Centrality, the Degree of centrality, and the Eigenvector Centrality. The results of the centrality measurement of the course achievement network are depicted in Table 2. According to the degree of centrality measurement results of Fundamental of Mathematics, Linear Algebra and Application, Graph Theory, Statistics for Research and Searching in Mathematics have the high degree of centrality ranked within the network whereas Practicum II, Preparation for Field Experience in Teaching Profession, Seminar mathematics, Mathematics for Specific Skills and Development of Skill and Process Mathematics have the low degree of centrality ranked within the same network, respectively. as already depicted in Fig. 1. The group of courses with high degree centrality does have an effect on other courses and the knowledge of these courses is powerful also helps facilitate the study of other subjects [6]. The finding of the betweenness centrality issue showed that Psychology for Teachers with a score of 34.08, Graph Theory with a score of 28.87, Fundamental of Mathematics with a score of 26.78, Statistics Analysis for Teacher with a score of 25.98 and Statistics for Research with a score of 21.23 had the best rankings, respectively. These are major courses connected with knowledge with each other while Measurement and Evaluation Learning Mathematics, Curriculum Development for Mathematics, Preparation for Field Experience in Teaching Profession, Practicum II and Mathematics for Specific Skills are the relatively unique courses. Figure 2 was displayed the course network

assigned by the betweenness centrality values. Additionally, the essential nodes were calculated by the eigenvector centrality method with a relative value to all significant nodes in the connection [7]. The findings elaborated that Measurement and Evaluation Learning Mathematics with an eigenvector value of 1.0, following by Action Research in Mathematics.

Table 1. Nodes and corresponding descriptions within the network

Nodes no.	Name of course	Nodes no.	Name of course
S1	Measurement and Evaluation of Learning Mathematics	S23	Abstract Algebra
S2	Curriculum Development for Mathematics	S24	Linear Algebra and Applications
S3	Development of Skill and Process Mathematics	S25	Applied Probability
S4	Action Research in Mathematics Classroom	S26	Graph Theory
S5	Principles of Education	S27	Mathematical modeling
S6	Being Professional Teachers	S28	Mathematics Principle for Teacher
S7	Psychology for Teachers	S29	Calculus for Teacher I
S8	Educational Measurement and Evaluation	S30	Calculus for Teacher II
S9	Curriculum and Learning Measurement	S31	Number System for Teacher
S10	Classroom management	S32	Searching in Mathematics
S11	Innovation and Information Technology in Education	S33	Geometry for Mathematics Teacher
S12	Communicative Languages for Teachers	S34	Differential Equations for Teacher
S13	Research for Learning Development	S35	Programing for Mathematics Teacher
S14	Preparation for Field Experience in Teaching Profession	S36	History of Mathematics
S15	Practicum I	S37	Statistics for Research
S16	Practicum II	S38	English of Mathematics Teacher I
S17	Internship I	S39	English of Mathematics Teacher II
S18	Internship I	S40	Statistics Analysis for Teacher
S19	Fundamental of Mathematics	S41	Seminar Mathematics
S20	Set Theory	S42	Theory and Applied Teaching Mathematics
S21	Number Theory	S43	Mathematics for Specific Skills
S22	Discrete Mathematics		

The scores of 0.7138, 0.6312, 0.5565, and 0.5427 obtained from Classroom, Curriculum Development for Mathematics, Being Professional Teachers, and Principles of Education, respectively, represent the top five highest scores and by which can be inferred that these five interconnected nodes do have an influence over the whole courses. In Fig. 3, it showed the high eigenvector values expressed by the larger circle in the graph.

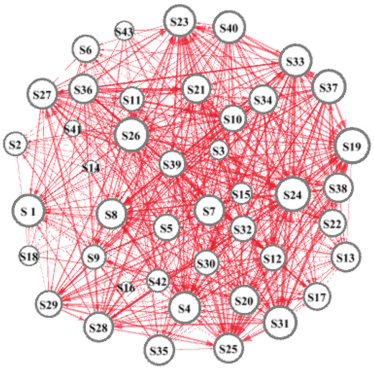

Fig. 1. The degree centrality network

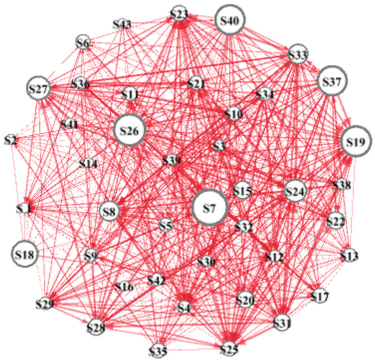

Fig. 2. The betweenness centrality network

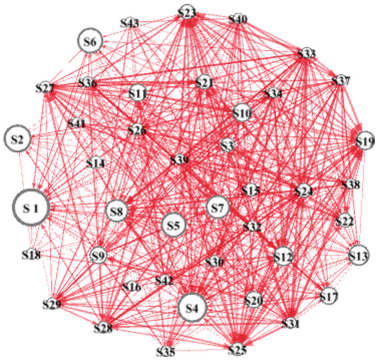

Fig. 3. The eigenvector centrality network

Table 2. Five order of centrality measurement using the courses achievement network

Node	Degree	Node	Betweenness	Node	Eigenvector
S19	35	S7	34.0767	S1	1.0000
S24	34	S26	28.8698	S4	0.7138
S26	33	S19	26.7732	S2	0.6311
S37	33	S40	25.9786	S6	0.5565
S31	32	S37	25.7377	S5	0.5427

4 Conclusion

The results of relations interconnection among course achievement using SNA offer the identifying role for each course in the Mathematics Education curriculum in various conditions. The results show that Fundamental of Mathematics, Graph Theory, Statistics for Research, Linear Algebra and Applications, and Psychology for Teachers are courses considered significant in the curriculum since they act and assume the key role for the remaining courses. Therefore, effective and efficient learning experiences are vital for subsequent students' achievement. Moreover, since there are courses depicting a high degree of centrality, alignments by resequencing the course of study for the first or second year, succeeding in taking these subjects are inevitable as they are ground for junior and senior years. Any early detection of the potentially unsucceeded nullified by immediate intervention of necessary means or assistance, student's success is quite highly likely intact. On the other hand, independent courses for which the low degree of centrality are experienced can be assigned as elective courses. Curriculum development or regeneration units can examine the emergence of the study as it exploratory data for further performing comprehensive analysis and designing course program suitably modified and corresponded to the Articulation and Balance, Continuity, Integration, and Sequence to accomplish the purposes of the course [8, 9].

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Management Projects Model to Reduce Lead Time of Base Station Telecom Construction in SME Based on Lean Focus and Agility

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Abstract. Sustainable growth in the telecommunications sector has led to many small- and medium-sized enterprises (SMEs) becoming involved in projects that are often not time and cost effective owing to the lack of a project management model that meets the needs of this type of company. In this article, a project management model is proposed based on the continuous improvement of processes under the lean and agility approach, and a medium enterprise from the sector is considered as a case study. A 50% reduction in the lead time of projects was observed, reprocessing and overtime were eliminated by 70%, while quality was ensured and the probability of project success increased. Thus, the application of this model solves the problem under study.

Keywords: Projects model · Construction · Lean · 5S · PMBOK

1 Introduction

The exponential growth experienced by the global telecommunications sector comes together with an increase in demand for projects to be addressed. This, in turn, has produced an emergence of small- and medium-sized enterprises (SMEs) seeking a position in this market to run projects that demand correct planning of costs and timings [1].

However, this is where the SMEs demonstrate their failings in meeting the times requested and the costs projected [2]. In Peru, the telecommunications sector has also experienced a significant growth of 6.95% [3]. Despite this, the infrastructure is still deficient in meeting the demand for mobile phones in 2022 [4], demonstrating a latent market for new companies wishing to enter either directly or through outsourcing.

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These are mostly SMEs, which do not have the support of a parent company and thus require more tools to help them benefit better from their projects.

Despite the growth in popularity of the PMBOK Guide in Peru, projects still lack holistic vision and all efforts are focused on budgeted costs and time management is left aside [5]. In terms of construction projects, time and cost are essential areas that come to the forefront when it comes to their management [6]. For this reason, in construction projects, which normally involve a significant amount of cost investment, it is of utmost importance to manage costs in the interest of not only the contractor but also the client [7]. Time management, however, is mostly related to managing the schedule. It involves determining the status of the project schedule, determining if changes have occurred or should occur, and influencing and managing any changes to the schedule [8].

2 State of the Art

2.1 Project Management Models + Lean

One of the most widely used components in project management models is lean methodology, since this methodology is recognized to benefit businesses in terms of efficiency, waste reduction, and workflow improvements for the whole organization, among other benefits [9], and [10]. Many studies have shown good results when applying lean methodology through its application in companies, as part of a case study, in which, by dealing with specific problems, such as delays in construction projects and unnecessary use of resources, they managed to mitigate these problems, improve construction processes, and reduce the waste generated in projects. However, during the application process, they also identified and documented, as part of their research, the difficulties encountered along the way, such as the difficulty workers experience when adapting to change [9], and [10].

2.2 Project Management Models + Agile Methodologies

The studies compiled on agile methodology applications show the benefits of applying these methodologies [11], and [12]. A benefit mentioned in most studies [11], and [12] is project control, since agile methodologies, such as Scrum, propose daily meetings under an established fifteen-minute format, during which topics such as what activities were conducted on the previous day, what problems arose the previous day, and what activities should be conducted on that day are discussed. Furthermore, other benefits, namely, rapid adaptation to customer requirements, rapid response, efficiency, and self-managed work teams have been mentioned [11], and [12].

3 Contribution

3.1 Proposed Model

The proposed model (see Fig. 1) generates synergy between project management and project management. This is divided into five stages within which the first stage of the model called diagnosis and implementation is applied to the organization in general, while the other four stages called planning, execution, closing, and monitoring and control are applied to the cellular station construction projects made by the telecommunications company. These four stages seek to reduce project closing times.

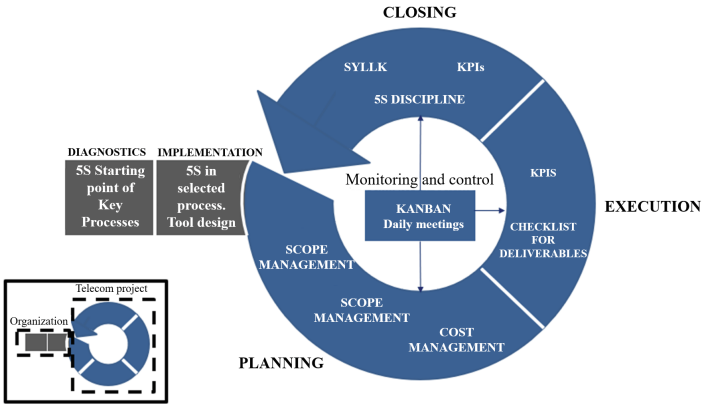

Fig. 1. Improvement final stage model

Diagnosis and Implementation. The purpose of the diagnosis and implementation stage is based on process management in the organization directly affecting construction project development. This makes the use of lean tools for workflow without wasting an important technique for obtaining successful projects [11], for which, the 5S methodology is used because it is a versatile and low-cost tool when applied.

Planning. Its purpose is to avoid possible reprocessing in the construction for this task by identifying processes, their inputs, outputs, times, and costs in a single deliverable which can be circulated to all interested parties of the project and managed within the same scope of this project.

Execution. The purpose of the project's execution lies in avoiding the possible reprocessing in the construction. For this task, the aforementioned planning format was designed, which has the inputs and outputs of each process along with their schedule, so that this becomes a daily checklist facilitating the identification of problems during operation and allowing immediate decisions to be made. This checklist offers results based on compliance and project progress.

Closing. The purpose of the closing stage is to verify compliance with the objectives of the model, measuring the results of the previous stages through KPIs and documenting lessons learned so that they serve as inputs in future projects.

Monitoring and Control. The purpose of monitoring and controlling the model is to guarantee compliance with closure indicator goals, solving the problems at the time of their occurrence and preventing them from spreading to the other parts of the project.

3.2 Proposed Method

(See Fig. 2).

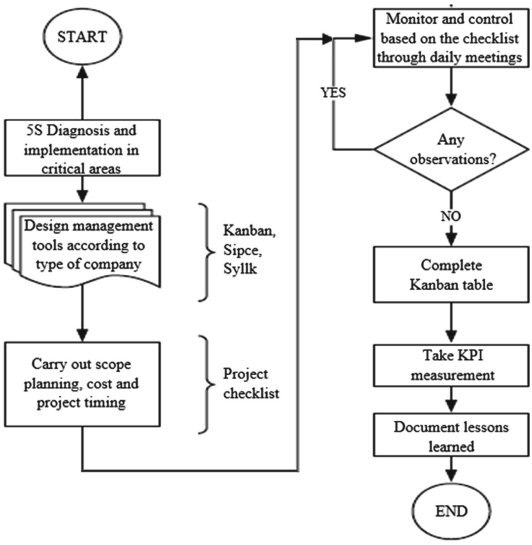

Fig. 2. Proposed method

3.3 Indicators

Indicator 1. Project lead time, its purpose is to measure the effectiveness of our model with respect to the reduction in timings; this indicator's formula is shown below.

$$\frac{Lead\ time\ period(n) - Lead\ time\ period(n+1)}{Lead\ time\ period(n)} \geq 30\% \quad (1)$$

The results of this indicator are interpreted as the project timings of the current period where the model is applied must have a minimum duration of 30% less than the period in comparison.

Indicator 2. Observed Projects, the purpose of this indicator is to measure the reduction of reprocesses generated by observed projects. The formula for this indicator is shown below.

$$\frac{\#Projects\ observed}{\#of\ total\ projects} \leq 10\% \tag{2}$$

The observations obtained in a specific period should not exceed 10% of the total of projects conducted.

Indicator 3. Variation of what is planned versus what is real, aims to optimize time and cost estimates as accurately as possible. The formula for this indicator is shown below.

$$\frac{Real\ planning - Initial\ planning}{Real\ planning} \pm 10\% \tag{3}$$

4 Validation

4.1 Case Study

As a case study, the model was implemented in a Peruvian company within the telecommunications sector called CJ TELECOM SAC, this is a Peruvian company with 15 years of experience in the telecommunications market, conducting construction work on telecommunications infrastructure for the main operators in the country, such as the company AMERICA MOVIL PERU SAC, It should be noted that the company invoiced around S/. 10,598,004.00 in 2018, which puts it in the position of a medium-sized company. This company has approximately 100 workers of which more than 80% are operational personnel, since the core of the business is field work.

4.2 Initial Diagnosis of the Case Study

The results obtained showed the project closing phase times to be 300% greater than ideal, mainly caused by reprocessing and raising of observations from the client. This problem caused delays in the billing of projects, so the company resorted to external financing on which interest had to be paid for pending projects. On the other hand, during the first visits made to the company, there was much disorder and lack of cleanliness in the company's warehouse, and by means of a Spaghetti diagram, it could be seen more clearly that some daily tasks were not performed efficiently in the warehouse (Table 1).

Table 1. Table of initial indicators

Indicator	Name	Goal	Initial result
1	Project lead time	$\geq 30\%$	0%
2	Project lead time	$\leq 10\%$	73.65%
3	Variation of what is planned vs real	$\pm 10\%$	88%

4.3 Results Analysis

The analysis of the final indicators shows that all stated goals were fulfilled, for the case of indicator 1, the project's lead time was reduced by 64%, thus fulfilling the 30% target (Table 2).

Table 2. Results analysis

Indicator	Name	Initial result	Final result
1	Project lead time	0%	64%
2	Project lead time	73.65%	0%
3	Variation of what is planned vs real	88%	22%

Regarding indicator 2, the results demonstrate the elimination of observations and reprocessing to be extremely beneficial in reducing financial and economic impacts.

Regarding indicator 3, the desired results were not obtained owing to a lack of personnel awareness on some of the proposed model's processes.

5 Conclusions

Application of the model was able to significantly reduce the initial indicators of the diagnosis, thus achieving a reduction of more than 60% of the lead time on closure and eliminating project reprocessing through accurate planning. Therefore, the application of this model to other scenarios is justified to reduce project lead time in medium-sized companies conducting construction projects in the telecommunication sector.

Although the proposed model had positive results and reduced closing time, the model varied when it came to the planned lead time by 22%, owing to the additional time used in planning and execution. However, we believe that encouraging personnel training and focusing on the agility approach and other new processes will reduce this time.

The use of agility techniques applied to monitoring and control allowed the project objectives to be met in an efficient manner, by reducing project observations and reprocessing to 0%. Reducing observations and reprocessing has a direct relationship with reducing financial and economic impacts, among others, such as opportunity costs. However, its application involves applying soft abilities and skills required by the project manager, which are not addressed by this research.

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Drilling-and-Blasting Mesh Design for Underground Mining Using the Holmberg Method

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Abstract. To optimize the drilling and blasting process in underground mining using the Holmberg method to create the drilling-and-blasting mesh design. The method it is an experimental applied-type and correlational-level inductive method. The Holmberg method showed good efficiency of 95% because it works with the rock mass and volatility-index parameters of the rock. The total drilling and blasting time with the Holmberg method is 2 h, whereas with the traditional method it will be 8 h because the blasting will not be efficient and there will be an increase in the amount of cutting and/or drilling time. The total cost of the drilling and blasting process in the Holmberg method is 2143.85 soles, while with the traditional method, it is 2820.75 soles, without taking into account the loss and shutdown of production that this would cause.

Keywords: Blasting mesh · Underground mining · Holmberg

1 Introduction

The mining sector in Peru is one of the pillars of the Peruvian economy and exports. Mining provides 20% of tax revenues, approximately 15% of the national gross domestic product (GDP), and 60% of exports. Most mines in Peru are concentrated in the Andes region. The main mining products of Peru are silver, copper, zinc, tin, bismuth, and tellurium.

It has gained importance concerning its economic impact on different countries in terms of exports, mining investment, and taxes, among other aspects; however, there is also an important relationship regarding social conflicts originated in the mining sector.

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Therefore, promoting domestic and foreign investments in this area and creating mechanisms that facilitate easy access to investments is one of the priorities of the State Policy.

Therefore, improvements that increase production efficiency, decrease costs and times, increase mineral recovery, decrease substantial losses, and increase profits are always sought.

2 Literature Review

If the drilling process is not optimal, all consequent processes will be affected. Further, low efficiency in the drilling meshes application was observed; therefore, a solution to redesign the drilling meshes to improve drilling efficiency was given using the Roger Holmerg methodology, performing a strict control on drilling times, improving the parallelism in drilled holes, and calculating the load factor [1, 2].

Main action plans in order to optimize the drilling and blasting process, these were the integral control in the unit operations and the optimal use of the types of explosives, allowing them to detect the gaps in the processes mapping, verifying the drilling mesh quality, well drilling, loading and the last blasting process in order to deliver it on the ground. Further, they improved the use of explosives and redesigned standard meshes for the work [3, 4].

Rebolledo Espinoza [5] proposes five steps: Massif classification for blasting; mine zoning according to blasting geotechnics; geotechnically drilling mesh design; controlled blasting planning; and finally, the implementation of drilling and controlled blasting designs, to solve problems and improve efficiency in unit processes using a controlled blasting planning and design methodology [6, 7].

3 Contribution

3.1 Data for the Drilling Process

The drilling will be performed with the ATLAS BOOMER 282 jumbo, both of which have 2 arms with a 16-foot bar with an efficient 14-foot drill; there is no control with the drilling of the meshes.

Table 1. Data for drilling mesh design

Relief drill diameter (D)	0.100 m
Production drill diameter (d)	0.045 m
Number of relief drills (N)	4
Explosive density (ρ)	0.850 gr/cm^3
Specific gravity (SG)	3 TM/m^3
Simple compression resistance (RC)	70 Mpa
Explosive energy (Q)	1140 kcal
Explosive gas volume (V)	920 l/kg
Angular deviation (α)	0.00012 mm/m
Deviation per tie (β)	0.005 m
Working width	4 m
Working height	4 m
Hard Rock	IIA
Geological dip	60°
Discontinuity spacing	0.3 m
Discontinuities geological dipping perpendicular to the tunnel axis	
Irregular blocks	

3.2 Data for Drilling Mesh Design

(See Table 1).

3.3 Data Calculation (Holmberg Method)

• Working with four relief drills

$\varnothing = \sqrt{N} * D$ (1)

Where:

ϕ: Working diameter;

N: drills number;

D: relief drill diameter

• Working diameter calculation

$\omega = \sqrt{4} * 0.1 = 0.2m$ (2)

• Drill depth

$H = 0.15 + 34.1 * \omega - 39.4 * \omega^2 = 5.394$ m (3)

• Progress calculation

$Hprogress = H * 0.9 = 4.8546$ m (4)

• Cap calculation

$t = \frac{1}{3} * H = \frac{1}{3} * 5.394 = 1.798$ m (5)

• Volume per loaded drill calculation

$V = \Pi * \frac{d^2}{4} * (H - t) = 5.719 * 10^{-3} \text{m}^3$ (6)

• Explosive quantity per drill calculation

$E = V * explosive\ density = 5.719 m^3 * 850\ \text{kg/m}^3 = 4.86\ \text{kg}/drill$ (7)

$V = \frac{920\text{l}}{kg} * \frac{1\ \text{m}^3}{1000\ \text{l}} = 0.920 \frac{\text{m}^3}{\text{kg}}$ (12)

$S = \frac{5}{6} * \frac{4.772}{5} + \frac{1}{6} * \frac{0.9209}{0.85} = 1.16$ (13)

• SGI calculation

$SGI = 25 * 3 - 50 = 25$ (14)

• RSI calculation

$RSI = 0.05 * 70 = 3.5$ (15)

• BI calculation

$BI = 5 * (RMD + JPS + JPO + SGI + RSI) = 642.5$ (16)

• ANFO "FCANFO" load factor calculation

$FC = 0.004 * BI = 2.57\ \text{kg/m}^3$ (17)

$FC_{ANFO} = \frac{FC * 900}{SEM\ EXSA\ EXPLOSIVE\ ENERGY\ 80\ (Kcal/kg)} = \frac{2.57 * 900}{1000} = 2.31\ \text{kg/m}^3$ (18)

• K calculation

$K = \frac{1.0014 \times 1.16 \times 0.4 \times 0.12^{1.15}}{55 \times 0.045 \times 2.57} = 6.5337 \times 10^{-3}$ (19)

• Burden (V1) of the quadrangle I calculation

$V^{2.5} = \frac{0.2}{2} \times V^{1.5} - 6.5337 \times 10^3 = 0 \quad V > 0$ (20)

$V_2 = \mathbf{8.8} \times \mathbf{10^{-2}} \times \sqrt{\frac{B \times I \times S_{ANFO}}{d \times C \times 0.4}}$ (21)

• Fixation factor

$F = H \times \alpha + \beta$ (22)

H: Drill length = 5.39 m

(*continued*)

(*continued*)

• Load concentration "I"

$$I = \frac{QUANTITY\ OF\ EXPLOSIVE\ FOR\ A\ DRILL}{Hprogress} = \frac{4.86\ \text{Kg}}{4.8546\ \text{m}} = 1.0014\ \text{kg/m} \quad (8)$$

• SANFO calculation

$$S = \frac{5}{6} * \frac{Q}{Qo} + \frac{1}{6} * \frac{V}{Vo} \quad (9)$$

Q: explosive energy in MJ

Qo: explosive energy in MJ considering 4.772 MJ

V: gas volume m^3/kg

Vo: gas volume m^3/kg considering 0.920 m^3/kg

$$SANFO = \frac{S}{0.84} \quad (10)$$

$$Q = \frac{1140\ \text{Kcal}}{kg} * \frac{4.1858\ \text{J}}{cal} = \frac{4.772\ \text{Mj}}{kg} \quad (11)$$

α: angular deviation = 0.00012 mm/m

β: deviation per tie = 0.005 m

$$F = 5.39 \times 0.00012 + 0.005 \quad (23)$$
$$F = 0.0056\ \text{m}$$

• Free face surface

$$B = \sqrt{2} \times (V_1 - F)$$
$$B = \sqrt{2} \times (0.19 - 0.0056) \quad (24)$$
$$B = 0.261\ \text{m}$$

• Free face Surface without factor

$$B^I = \sqrt{2} \times (V_1) = \mathbf{0.269\ m}$$

$$V_2 = 8.8 \times 10^{-2} \times \sqrt{\frac{0.261 \times 1.0014 \times 1.1615}{0.045 \times 2.57 \times 0.4}} = 0.23\ \text{m} \quad (25)$$

- Calculation of the load factor "fc" and the volatility index of lilly corrected for underground mining "bi" (Table 2).

Table 2. Corrected parameters for LILLY in underground mining

Geomechanical parameters	Qualification
Rock Massif Description (RMD)	
Intense fracturing	20
Blocks and layers	30
Irregular blocks	40
Regular blocks	50
Joints Planes Spacing (JPS)	
<0.06 m	10
0.06–0.2 m	20
0.2–0.6 m	30
0.6–2 m	40
>2 m	50
Joint Planes Orientation (JPO)	
Direction perpendicular to the tunnel axis	
Digging with geological dip	
Geological dip 45°–90°	40
Geological dip 20°–45°	35
Digging against geological dip	
Geological dip 45°–90°	30
Geological dip 20°–45°	25
Direction parallel to the tunnel axis	
Geological dip 20°–45°	15
Geological dip 45°–90°	10
Geological dip 0°–20° any direction	10
Specific Gravity Influence (SGI)	
SGI = 25 × SG − 50	SG: specific gravity
Relative Strength Index (RSI)	
RSI = 0.05 × RC	RC: simple compression resistance (MPa)

- QUADRANGLE I

Table 3. Data summary Quadrangle II

Load concentration (I) kg/m	1.0014
ANFO load factor	2.57
SANFO	1.1615
Production drill diameter	0.045 m
Equivalent diameter	0.2 m
Burden 1 (V_1)	0.19 m

- The wells are connected with a bidirectional detonating cordso that all the wells are connected. After this mooring, the detonation is conducted (Fig. 1) (Table 3).
- The explosion-energy distribution is analyzed to determine how effective the blasting was. In this case, this distribution can be seen in Fig. 2.

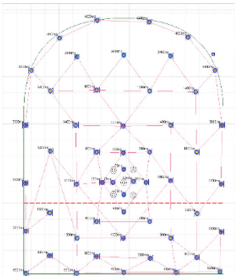

Fig. 1. Power distribution in drilling mesh

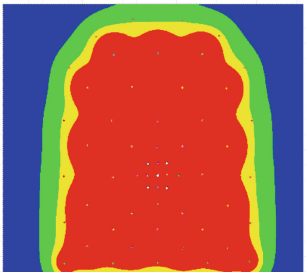

Fig. 2. Explosion-energy distribution

3.4 Simulation in Jk Simblast Software (Traditional Method—Exsa)

- All drills were loaded.
- The ANFO explosive and first APD were put in place to ensure the detonation.
- The drills were joined with the main detonating cord; a detonation speed was exclusive to the first (Fig. 3).
- The energy distribution is analyzed; a low blasting quality is observed in the analysis (Fig. 4).

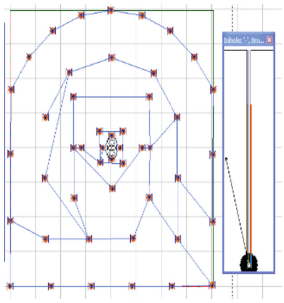

Fig. 3. Mesh-loaded drills (4 × 4)

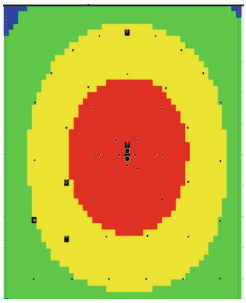

Fig. 4. Energy-distribution analysis (traditional method)

3.5 Results Discussion

Efficiency

Holmberg method: good efficiency since it works with parameters of the rock massif and rock volatility index. E = 95%
Traditional method: 65% efficiency since it explodes but does not fully cover the walls of the work front. E = 75%

Time

Holmberg method: The drilling and blasting is approximately 2 h, only these processes. T = 2 h.
Traditional method: The work will not only be drilling and blasting but cleaning, deflection and/or drilling, which will be given in almost a whole guard. T = 8 h.

Costs
(See Table 4).

Table 4. Cost comparison

Principal costs	Holmberg method	Traditional method
Worker labor force	24.00 soles	96.00 soles
Drilling Master labor force	28.00 soles	112.00 soles
explosive to be used (Anfo)	640.00 soles	800.00 soles
Jumbo Boomer 182	615.12 soles	615.12 soles
Compressor 1050 cfpm		247.50 soles
Bomb	6.47 soles	6.47 soles
Fan	24.59 soles	24.59 soles
Truck	227.90 soles	227.90 soles
Power generator	99.00 soles	99.00 soles
Scooptram	478.77 soles	478.77 soles
Jackleg		113.40 soles
Total	2143.85 soles	2820.75 soles

4 Conclusions

The efficiency of the Holmberg method to create drilling meshes is 95% because it is perfect in the simulation and this yields 95% certainty; the traditional method has an efficiency of 75%.

The total drilling and blasting time with the Holmberg method is 2 h, while with the traditional method will be 8 h because the blasting will not be efficient and the time consumed during the processes of cutting and/or drilling will be increased.

The total drilling and blasting costs by the Holmberg and traditional methods are 2143.85 and 2820.75 soles, respectively, without taking into account the loss and shutdown of production that this would cause.

The total drilling and blasting budget exceeds 31.5% using the traditional method.

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Tennis Organization Service for Middle-Aged and Elderly People in Wuhan

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Abstract. Through the methods of literature, questionnaires, expert interviews and mathematical statistics, this paper investigates tennis organization service of in the middle-aged and elderly people in Wuhan. The results show that: there is a lack of scientific guidance for tennis organization of middle-aged and elderly people. The municipal government has not given enough support for middle-aged and elderly people to participate in tennis. Middle-aged and elderly people are easy to get sports injury when they take part in tennis. Tennis court facilities are not complete. Some organizations and services need to be improved during tennis.

Keywords: Wuhan · Middle-aged and elderly · Tennis · Organization and service

1 Introduction

Tennis is deeply loved by middle-aged and elderly people, because it is not only highly ornamental and interesting, but also the intensity of tennis sports can be adjusted according to the physical condition of the participants, so that the participants have a comfortable intensity of sports [1]. Tennis brings happiness to middle-aged and elderly people as well as physical health [2]. However, there is no scientific organization and service for middle-aged and elderly people to play tennis, which may cause bad effects on the body [3]. By investigating the tennis of some middle-aged and elderly people in Wuhan, I find that there are many problems existing in middle-aged and elderly people in Wuhan when they participate in tennis. Through the study of this article, I hope that it can provide scientific guidance for developing the tennis in middle-aged and elderly people in Wuhan, promoting the better development of tennis for middle-aged and elderly people in Wuhan [4, 5].

2 Objects and Methods

2.1 Object

This article focuses on the middle-aged and elderly people who have participated in tennis for a long time in the stadiums of Wuhan Sports University, Tennis Court, Hongshan Gymnasium, and Oya Tennis Club.

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2.2 Methods

2.2.1 Literature

Aimed to provide theoretical basis for further research in this paper, the author find out related sports books such as sports psychology, sports training, sports rehabilitation, etc., consult the official website of the State General Administration of Sports about the development of tennis for middle-aged and elderly people, and query the literature of the organization and services of middle-aged and elderly people participating in sports.

2.2.2 Questionnaire Survey

Based on the previous reference books and related literature, in order to learn about the factors restricting tennis in the survey, a questionnaire was designed. A total of 120 questionnaires were distributed to the middle-aged and elderly people who play tennis, 40 questionnaires for court of Wuhan Sports University, 40 questionnaires for the Hongshan Stadium tennis court, and 40 for Oya Tennis Club. Table 1 is statistics of the questionnaires issued and collected.

Table 1. Statistics of the questionnaires issued and collected

Survey location	Questionnaires issued	Number of recycling questionnaires	Number of valid questionnaires	Recovery rate/%	Efficient/%
Faculty tennis court of Wuhan Sports University	40	40	39	100	97.5
Hongshan stadium tennis court	40	38	38	95	100
Oya tennis club	40	36	35	90	97.2

2.2.3 Expert Interview

Aimed to provide a more powerful basis for this paper, 5 professors and 3 associate professors were interviewed in Wuhan Sports University and School of Physical Education in Central China Normal University.

2.2.4 Mathematical Statistics

The processed materials will be summarized and summarized, and then explained in the list. Data will be provided to further modify and improve the paper, enrich the content, and enhance the views.

3 Results and Analysis

With the rapid development of China's economy and the continuous improvement of people's living standards, tennis has gradually entered everyone's field of vision and has become a popular sport. With the Wuhan Tennis Open settled in Wuhan, the

world's top women's tennis players also appeared in front of the people of Wuhan, greatly advancing and encouraging people to participate in tennis game. Table 2 is distribution of tennis courts in Wuhan.

Table 2. Distribution of tennis courts in Wuhan

Site distribution
College
Sports center, tennis center
Government unit, enterprise
Club
Community

There are many colleges and universities in Wuhan, and most of them have tennis courts, especially the Wuhan Sports University, which has 34 tennis courts. As representatives of colleges and universities, some colleges and universities have enough courts. The venue is also more in Sports Center and Tennis Center because of Wuhan Tennis Open settled in Wuhan. Besides, most government units and enterprises also have their own tennis courts. For example, Wuhan Real Estate Group has four courts for internal and the surrounding people. As a representative, Oya Tennis Club also has its own venues in different areas of Wuhan, but most of them are used for internal teaching. Some newly built communities in Wuhan are equipped with tennis courts. In formerly densely populated communities, there were few tennis courts.

With a strong interest and entertain, the amount of exercise can be large or small, Tennis is a sports loved by middle-aged and elderly people. According to actual and expert arguments, tennis is the most suitable sport for middle-aged and elderly people in all sports. Tennis make us happy, especially in the game field and in the process of match wits, we cheer for myself, also applaud for the opponent hit a good shot. Middle-aged and elderly people participate in tennis, mainly to strengthen the body, and increase the communication between friends. Based on the distribution of tennis courts in Wuhan, the organization and management of middle-aged and elderly people's participation in tennis were analyzed. Table 3 is Tennis court organization and management form.

Table 3. Tennis court organization and management form

Site distribution	Organization and management
College	Regular organization and scientific guidance
Sports center, tennis center	Spontaneous organization
Government unit, enterprise	Official organization, scientific guidance
Club	Economical operation management
Community	Spontaneous organization

Although there are many tennis courts in colleges and universities, they are mainly used for teaching, Moreover, colleges and universities in Wuhan are concentrated in Wuchang district, so there are few courts for middle-aged and elderly people. The sports center site, because of the new, and far from the city, is difficult to use. Government units and enterprises have tennis courts, and their organization and management are more reasonable. However, not all middle-aged and elderly people can participate in the competition, so the popularity is not enough. The main purpose of the club is to make money. The middle-aged and the elderly can use the court for a fee and play tennis. There are tennis courts in some communities, but there are unused, improperly managed, or unmanaged fields that make the courts abandoned. There are no tennis courts in some tennis communities.

Through the questionnaire, the main factors restricting the tennis of middle-aged and elderly people in Wuhan were analyzed. Table 4 is constraints survey.

Table 4. Constraints survey (n = 112)

Constraints	Number	Percentage/%
Lack of scientific guidance	31	27.7
Insufficient government support	17	15.1
Sports injury	26	23.2
Insufficient venue facilities	18	16.1
Organizations and services need to be improved	15	13.4
Other	4	3.7

Among the surveyed restrictive factors of tennis in middle-aged and elderly people in Wuhan, 27.7% believed that they lacked scientific guidance; 23.2% considered sports injuries; and 16.1% believed that the venue facilities were not sound; 15.1% believed that the policy support was insufficient; 13.4% The organization and service need to be improved; 3.7% considered other factors. The main reason is the lack of scientific guidance. Tennis is a sport with high technical requirements. With the growth of age, middle-aged and elderly people gradually lose their attention and concentration, and their reaction ability becomes slower. In tennis, especially during the game, it is easy to get sports injuries. Sports injury is the main factor restricting the participation of middle-aged and elderly people in sports. Middle-aged and elderly people all have some physical injuries. In terms of policy support, there is a difference between the actual situation and middle-aged and elderly people's participation in sports, and the policy implementation is not perfect. Court facilities mainly exist in the absence of courts and tennis groups can't find courts timely because of there is no tennis court nearby, and some good courts in the outer suburbs. In the organized tennis matches, there is not enough attention paid to the middle-aged and elderly people, and medical personnel responded to emergencies before and during the matches.

Through a case study on the tennis court of faculty and staff of Wuhan Sports University from 2018 to 2019, a corresponding plan was made for the organization and service of tennis for the middle-aged and elderly people. Finally, a more reasonable

plan was formed through continuous improvement and practice. Table 5 is basic information of organization and service plan objects.

Table 5. Basic information of organization and service plan objects

Name	Age	Gender	Occupation	Ball age
Zhang	52	Male	Teacher	12
Wang	57	Female	Teacher's family	8
Zhou	53	Male	Freelancers	9
Liu	56	Male	Enterprise	8
Li	49	Female	Teacher	10

The graduates majored in tennis from Wuhan Sports University will provide technical guidance, and the graduates majored in sports rehabilitation will publicity sports injury prevention knowledge and explain and demonstrate sports injury treatment methods. According to the different sports injuries, the middle-aged and elderly body function and different skill levels, the middle-aged and elderly people are mentored by the graduates, and then are divided into groups, arranged exercise intensity, time, so that middle-aged and elderly people participate in tennis game reasonably, to increase the enthusiasm and interest of tennis. Table 6 is constitution and technical effect table.

Table 6. Constitution and technical effect table

Name	Zhang		Wang		Zhou		Liu		Li	
Time/year	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
Weight/kg	82	78	63	62	72	68	76	73	60	60
Blood sugar	6.3	5.9	5.2	5.0	5.8	5.6	6.5	6.4	5.9	6.0
Blood pressure	150/97	141/89	145/88	140/87	137/79	135/76	143/90	144/88	139/87	136/85
TCHO	6.2	5.9	5.8	5.6	6.0	5.8	6.3	5.9	5.7	5.2
TG	2.3	1.9	1.9	1.7	2.3	2.1	1.8	1.7	2.3	2.1
HDL-C	1.2	1.4	1.3	1.5	0.9	1.1	1.2	1.3	1.1	1.3
LDL-G	2.8	2.7	2.6	2.4	2.8	2.7	3.2	3.2	3.1	3.2
Technology	Improve		Improve		Improve		Improve		Improve	

4 Conclusions

The middle-aged and elderly people's tennis games in Wuhan are mainly distributed in universities, sports centers, tennis centers, clubs and communities. The tennis competitions are organized in a variety of forms without scale or influence. The main factors restricting middle-aged and elderly people's tennis in Wuhan are lack of scientific guidance, sports injury, incomplete venue facilities, insufficient government support, and the organization and service need to be improved. According to the case

analysis of the faculty and tennis court of Wuhan Sports University, the study subjects showed certain improvement in function, stronger interest in tennis, certain improvement in blood glucose, blood pressure, blood lipid, etc., and small range of weight loss.

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Analysis of the Work System in an Object of the New Media and the Effects Generated in the Processes of Interaction with a Weak - Visual Person

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Abstract. It has been detected through static and dynamic networks, that the Interoceptive responses, during the interaction processes in a YouTube work system with a weak - visual person, are modified based on the greater or lesser use of Fine Motor Interaction. In addition, there is a constancy in the Focal Attention processes generated by two fundamental factors: Fine motor interaction and Sound interaction. Likewise, studies show that the decrease in the processes of fine motor interaction in a weak - visual person in the YouTube work system decreases Interoceptive responses of stress, and tend to focus on audible symbols during the interaction process. Therefore, the intention of these studies is to promote reflections on the appropriate use in the objects of the new media based on the effects and processes of interaction generated in a weak - visual person.

Keywords: Human interaction processes · New media · Focal Attention Process · Weak-visual person · YouTube · Functional diversity

1 Introduction

People execute different typologies of interaction through the work systems of the new media [1] to obtain specific information, in which varied processes of human interaction take part. In this sense, the work systems of the new media require precision processes to be executed. In relation to this, the user uses different sensory mechanisms to access them.

The new media is used by a wide variety of users, many of them have problems with the visual system due to various causes: illness, age, accidents, among others. In the case of a weak - visual person (DV) stress responses [2] are observed during a specific stage of their interaction process. Which coincides with the processes of interaction with the YouTube work system; the specific user task that generates this kind of responses is relate in the location of the access button of the YouTube object and its pulsation to access in the content [3].

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Therefore, for these studies it is important to consider two stages in the process of interaction with a weak - visual person: the first referring to the interaction process carried out with the YouTube work system[1] and the second related to the interaction process with the YouTube object[2].

2 Description of the Process

The studies were developed from the observation in the interaction process carried out by a weak - visual person with the YouTube work system. Static networks were used to represent the activation of sensory mechanisms from the user tasks performed in the work system. Likewise, dynamic networks were used to represent the relationship between sensory mechanisms and the responses given by the user during the process. The process was analyzed in three stages: The first one represented the activation of the sensory mechanisms on a user in relation with the user tasks in whole process. The second one showed the relationship of the sensory mechanisms and the responses in the weak - visual person during the process of interaction with the YouTube work system. The third one showed the relationship of the sensory mechanisms and the responses in the weak - visual person in the process of interaction with the YouTube object.

2.1 Methodology

The methodology used for these studies was Learning Analytics with comparative analysis of data obtained with the design of adjacency matrices and use of static and dynamic networks for the visualization of information. For these studies the interaction processes performed by the user in the YouTube work system, the activation of sensory mechanisms and the responses given during the process, were considered in the construction of the networks. The use of this methodology was applied in a weak - visual person who executed the following tasks: 1. Locate the X YouTube object in the work system of a cell phone. 2. Enter to the X YouTube object. 3. Receive the information of the X YouTube object.

The following tables and figures describe the analysis process (Tables 1, 2, 3 and Fig. 1):

Table 1. General nomenclature.

Sign	Description	Sign	Description	Sign	Description
Iv	Visual Interaction	Is	Sound interaction	Pd	Digital pressure
Prop	Propioception	Intero	Interoception	S	Symbol
Imf	Fine motor Interaction	Em	Emotion	Elem	Elements
Img	Gross motor Interaction	PAF	Focal Attention Process	PAG	General attention process

[1] The work system is the physical component of the Work System in which human work has an effect [4].

[2] Concerning to the Dynamic media: media in which the presentation to the user changes according to time Example: These include video, music, animation [3].

Table 2. Process adjacency matrix. Elaboration Olmos & Gil 2019.

	Img	Imf	Iv	Prop	Pd	Is	PAF	PAG	EA	Intero	S	Elem	Mlp	Mcp
Img	0	0	1	1	1	0	0	1	0	0	0	0	0	1
Imf	1	0	1	1	1	1	1	0	0	1	1	0	0	1
Iv	0	1	0	1	1	0	1	0	0	1	0	1	0	1
Prop	0	1	1	0	0	1	1	0	0	1	0	0	0	0
Pd	0	1	0	1	0	0	1	0	0	0	0	0	0	1
Is	0	0	0	0	0	0	1	0	0	0	1	0	1	0
PAF	0	0	0	0	0	1	0	0	0	1	1	0	1	0
PAG	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EA	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Intero	0	0	0	0	0	1	1	0	0	0	1	0	0	0
S	0	0	0	0	0	1	1	0	0	1	0	0	1	0
Elem	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mlp	0	0	0	0	0	1	0	0	0	0	1	0	0	0
Mcp	0	0	0	0	0	0	0	0	0	0	0	0	0	0

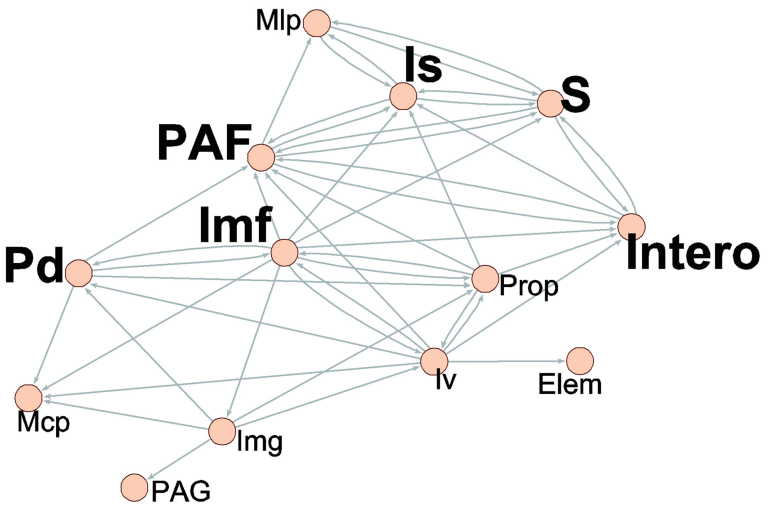

Fig. 1. Static network that shows the activation of the sensory mechanisms from the user in relation with the YouTube work system in whole process. Elaboration L. Olmos & J. Gil 2019.

In this first stage of the global study of the interaction process, the highest degrees can be perceived in Focal Attention Processes (PAF)[3], Fine motor interaction (Imf),

[3] "As a consequence of detection of a signal by this system, we can produce a wide range of arbitrary responses to it. We take this ability to produce arbitrary responses as evidence that the person is aware of the signal" [5].

Table 3. Node grades.

Sign	Grade	Sign	Grade	Sign	Grade	Sign	Grade
Iv	10	Is	9	PAF	11	Pd	7
Intero	8	S	9	Imf	12		

and Visual interaction (Iv). Likewise, it is observed that the factors related to the Focal Attention Processes (PAF) are the Sound Interaction (Is), the Fine Motor Interaction (Imf) and the Proprioception (Prop). And the factors that generate Interoceptive responses (Intero) are related to Sound Interaction (Is), Focal Attention Processes (PAF), and Fine Motor Interaction (Imf).

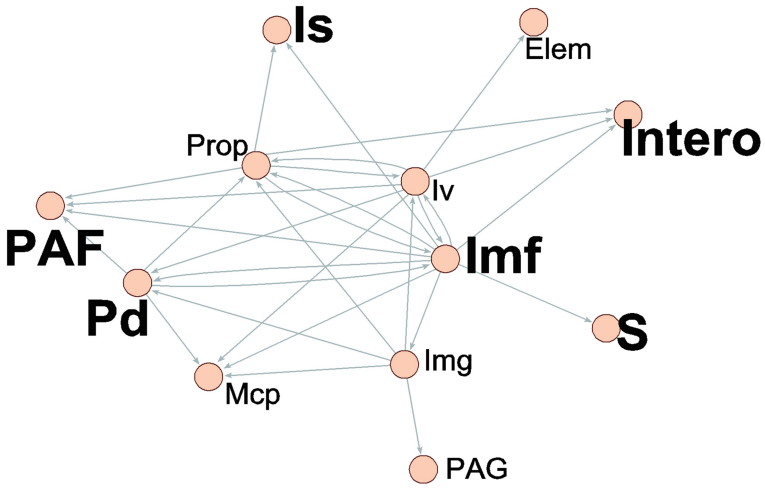

Fig. 2. Dynamic network that shows the relationship and distance of the sensory mechanisms in the first stage. Elaboration L. Olmos & J. Gil 2019.

Figure 2 shows a correlation with Focal Attention Processes (PAF) and the activation in the sensory mechanisms of Digital Pressure (Pd), Fine Motor Interaction (Imf) and Visual Interaction (Iv)., Also the correlation with the Focal Attention Processes (PAF) and the Proprioceptive responses (Prop). Likewise, a triadic correlation is observed between Focal Attention Processes (PAF), Proprioception (Prop) and Digital Pressure (Pd), the latter considered as a very specific variant of Fine Motor Interaction (Imf). There is also a triadic relationship between propioception (Prop), Fine motor interaction (Imf) and Digital Pressure (Pd). The link that is generated between Fine Motor Interaction (Imf), Proprioception (Prop) and Sound Interaction (Is) is notorious. Likewise, there is a distance 1 between Interoceptive responses (Intero) and Fine motor interaction (Imf)., And a distance 2 between Interoceptive responses (Intero) and symbolic information (S). Also, it is observed a considerable use of Visual Interaction (Iv) in relation with the Propioception (Prop), the Fine Motor Interaction (Imf) and the Digital Pressure (Pd) which is related with the YouTube work system access.

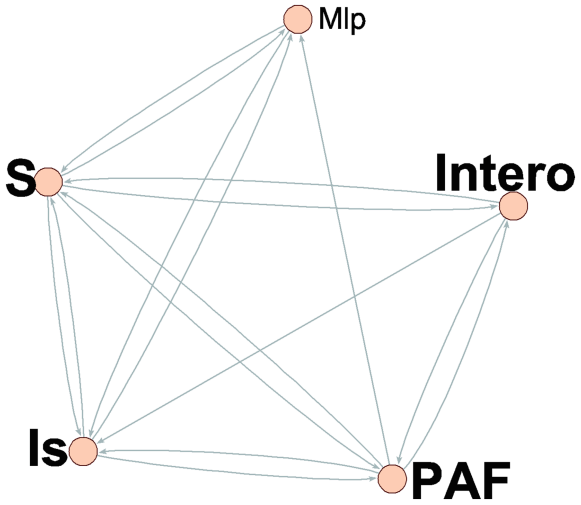

Fig. 3. Dynamic network that shows the relationship and distance of the sensory mechanisms in the second stage. Elaboration L. Olmos & J. Gil 2019.

Figure 3 shows a considerable reduction in the activation of the sensory mechanisms in the weak - visual person (Dv). However, it is observed that Focal Attention Processes (PAF) continue with a high grade in correlation with the sound Interaction (Is). In this second stage it is observed that Interoception (Intero) is related to the sound Interaction (Is) and Focal Attention Processes (PAF). Likewise, the Sound Interaction (Is) is linked with the transference of audible symbols, like is shown in Fig. 3. So, there is a probability that Interoceptive responses (Intero), at this stage, are determined by the understanding of the audible information, and not by the processes of Fine motor interaction (Imf). Is important to notify that on this stage the Fine motor interaction (Imf) was reduced to 0. Likewise, it is important to mention that the average distance between Interoception (Intero), Focal Attention Processes (PAF), Sound Interaction (Is), and Symbols (S) is 1, which indicates a close relationship.

3 Results

Based on the comparative data analysis the following results were given:

At first stage, it is observed that the weak - visual person uses the Focal Attention Processes (PAF) basically to get a correct spatial location (Prop) with the YouTube work system; Also with the use of fine motor Interaction (Imf) processes with the hand to access in the system. In addition, it is observed that the Interoceptive responses (Intero), of the weak - visual person, are given in relation to the spatial location using a strong activation of the mechanism of sight and fine motor interaction. All of this has an impact in the Focal Attention Processes (PAF). This stage of the process is described for the weak - visual person like stressful.

At the second stage, a noticeable change was perceive after the weak - visual person (Dv) accessed to the YouTube object. In which he continues keeping a constant use in the Focal Attention Processes (PAF) but now its orientation is directed to the audible symbols (S). Likewise, in this second stage there was a change in the factors that caused Interoceptive responses (Intero). In this part of the process the Interoceptive responses (Intero) were directly related to the Focal Attention Processes (PAF), Sound Interaction (Is) and the symbolic elements in the YouTube object. Based on this is probably to think, that in the second stage of the interaction processes, Interoceptive responses of stress are directly related to the understanding of audible information.

The constancy of the Focal Attention Processes (PAF) make us assume a cognitive spending in the weak - visual person throughout the process.

4 Conclusions

The processes to interact with the YouTube work system requires precision, which generate Focal Attention Processes in a weak - visual user in a first stage of the process. In which the relationship between Interoceptive responses and sensory mechanisms, used only to achieve a correct spatial location, is clear. It is perceived that a reduction of the Fine Motor Interaction processes in the linear work system of the YouTube object modifies the origin and typology of interoceptive responses in the following relationship: At a higher level of Fine Motor Interaction processes with a linear work system an increase in interoceptive stress responses is generated. At a lower level of Fine Motor Interaction processes in the linear work system, Interoceptive stress responses decrease. Those responses tend to focus on the process of interaction with the YouTube object and tend to change in relation to other factors, in this case to the audible symbols. Likewise, the Focal Attention processes is observed constantly throughout the interaction process in the weak - visual person, who requires a cognitive spending by the user, which implies a future modification to the interaction processes now related to the YouTube object and not with its work system.

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