



EURO PIM

IRC 2021

DORTMUND INTERNATIONAL RESEARCH CONFERENCE

CONFERENCE PROCEEDINGS – 24-26 JUNE 2021

- Education, Workplace & Employability
- Sustainability
- Digital Transformation
- Engineering & Informatics
- Innovation & Entrepreneurship
- Project Management

Dortmund International [Interactive] Research Conference 2021

The International Research Conference (IRC) at the Dortmund University of Applied Sciences and Arts (FH Dortmund) took place on June 24th – June 26th 2021 for the twelfth time.

Despite the Corona pandemic, the Dortmund IRC was successfully held in June 2021, for the second time in a digital setting. The Dortmund IRC sees itself as a platform and forum for international and interdisciplinary scientific networking. Around 300 people from 23 different countries took part in the annual event. A welcoming by the Prorector for International Relations and Diversity, Prof. Dr. Katrin Löhner, opened the Conference, which was followed by a greeting of the organisation team, and the InduTwin (Industrial Twin Bachelor Programme) project's representatives, who co-chaired and co-organised the IRC this year.

The conference was broadcasted live from the User Innovation Center (UIC), the Innovation Hub of FH Dortmund, which is located in the Institute for the Digital Transformation of Application and Living Domains (IDiAL). With a total of 46 accepted and presented contributions, an all-time-IRC high number was reached in the current year. Of these:

- 30 contributions in a (live) presentation format,
- 7 contributions in a poster format, and
- 9 contributions in a video format.

were presented. The best contributions in each format were awarded prizes at the closing ceremony.



The most attended stream "Session on Digital Transformation & Virtual Education" registered around 90 participants. In addition to the presented papers, workshops, guest lectures, panel discussions and social activities were offered which were characterised by a relaxed atmosphere. In addition, the participating partners of the international EuroPIM consortium (European Partnership for Project and Innovation Management) presented new research projects, upcoming events and future plans in an open discussion session. The representatives of the Erasmus+ Knowledge Alliance "Projects for the Digital Transformation (ProDiT)" opened the section "News and Stories from Consortium", followed by other colleagues who also had the opportunity to present their projects and plans. Furthermore, as another highlight and special guest, the Solar Car Team Bochum presented its more than 20 years of history during a workshop. Following the

presentation, the team conducted an online workshop tour and presented the progress of the new project. Finally, all participants could enjoy a live online ride in a solar car. Other recent topics such as Open Educational Resources (OER), contributed by Sina Nitzsche (coordinator and researcher at the Department of Digital Education at FH Dortmund) and modern data analytics techniques for extracting new insights from project data sources to solve organisational and societal problems, contributed by Nigel L. Williams (Research Director in the Organizations and Systems Management Subject Group at the University of Portsmouth) enriched the conference and rounded off the programme.

By incorporating numerous interactive elements, this year proved once again that an online conference does not mean less interactivity. All participants considered the two-and-a-half-day event a complete success. FH Dortmund succeeded in setting new quality standards this year with IRC 2021 and in becoming even bigger and more interactive.

This conference has its own spirit and power since it was founded by our honoured and very much missed teacher and friend Prof. Dr. Dr. h.c. mult. Peter A. Reusch in 2010.

A special thank you goes to the organizing team, headed by Ekaterina Mikhaylova and Ekaterina Hermann, the whole EuroPIM team, the student support team, and all the active and supportive members of the team & IRC family.

For the 7th time, the conference was followed by the Summer School in Dortmund, starting on June 28th and ending on July 2nd. The Summer School was taking place online and was organized into the following 6 streams:

- Automotive Systems (Carsten Wiecher)
- Scaled Agile Framework (SAFe) (Olha Mikhieieva)
- Software Engineering Project (Jonas Sorgalla)
- Sustainability and Quality in Project Management (Jose Ramon Otegi-Olaso)
- Computer Vision (Jörg Thiem)
- PhD Summer School (Nicola Vollmar)

In 2021 the conference had different sessions as highlighted above and various panel discussions. Presented papers were organized into the following sessions, covered on three days:

Thursday, June 24th:

Session on Project Management, Quality & Sustainability (José Ramón Otegi-Olaso)

- If We Were the Rulers of the World. Part III: Guidelines of a Project to Protect the World (Dr. Werner Wetekamp)
- The Concept of the Project and Program Portfolio Management Methodology in Integrated Functional Environments (Nataliia Yehorchenkova, Oleksii Yehorchenkov)
- The Consideration of Sustainability in Project Management and Technological Innovation for Organizational Strategy (Olanrewaju Isaac Odewale)
- Sustainable Project Management Versus Responsible Project Management: Evolution or Complement (Leticia Fuentes-Ardeo, Jose Ramon Otegi-Olaso)

Workshop “**Project Management Research and Practice Journal**” (Beverly Pasian)

Session on **Digital Transformation** (Christian Reimann)

- Role of BIM in Mitigating Information Asymmetry and Transparency: Reality Versus Expectation (Tausif Ahmed Ishtiaque, Ole Jonny Klakegg)
- The Necessity to Use Blockchain in IoT/ IIoT (Shazia Muhsi, Fatemeh Moradian Tehrani)
- Development of Machine Learning Maturity Scale (MLMS) Framework in the Context of Industry 4.0 (Sabit Shaikholla)

Poster Session

- Auto-refining Reconstruction Algorithm for Limited Angle Humanoid Reconstruction in Holographic Teleconferencing Applications (Audrius Kulikajevas, Rytis Maskeliūnas, Robertas Damaševičius, Marta Włodarczyk-Sielicka)
- Impact of COVID-19 Virus on IT Organizations: A Study of a Virtual Working System (Jovial Jose, Swapna Talla)
- Environmental Conditions Affecting the Sustainability of Open Metallic Structures (Marta Terrados-Cristos, Marina Diaz-Piloneta, Javier García-González, Cristina Alonso-Álvarez, Ana Fernández-Iglesias)
- How Could Organizations Help Their Employees Build Sense of Coherence During COVID-19 Outbreak? (Sevgi Emirza)
- Effects of Technical Risk on the Performance of Construction Projects (Suleman Malik, Anam Khan, Rao Aamir Khan)
- Exploring Predictive Analytics for Stock Prices: Looking towards Prescriptive Analytics (Aamod Vyas, Saket Mohanrao Lakhpati, Uphar Singh, Ayush Sinha, O.P. Vyas)
- Constructing Digital Transformation Index of Local Communities in Ukraine (Maryna Novozhylova, Olga Chub)

Session on **Workplace and Employability** (Mariella Olivos)

- Project Management as an Active Teaching Device That Fosters Students’ Employability (Erina Guraziu, Rodrigo Latorre Vivar)
- Alcoholism and Its Impact on the Workplace. A Brief Analysis (Diana del Consuelo Caldera González, Maria Guadalupe Arredondo Hidalgo, Eva Conraud, Miguel Agustín Ortega Carrillo)

Session on **Applications of Engineering and Computer Science** (Guillermo Artana)

- Development and Validation of a Gamified Videogame for Math Learning in Attention Deficit Hyperactivity Disorder (ADHD) Children (Rodrigo Castro Sugahara, Deyby Huamanchahua Canchanya)
- Numerical Simulation of a High-Speed Bumper Made With 6061-T6 Aluminum Alloy (Javier Serrano Pérez, Mónica Araceli Camacho Gonzalez, Maria del Consuelo Rueda Márquez, Nikté Martínez Palma)

Friday, June 25th:

Keynote Speech “**Open Educational Resources: Why it Matters and How You Can Join the Movement**” (Sina Nitzsche)

Session on **Education, e-Learning & Blended Learning** (Bassam Hussein)

- The Formation of Foreign Language Professional-Communicative Competence of IT Students and Teaching EPP with ICT (Aissulu Kaldarova and Tulebike Kulgildinova)
- Impact-Factor or Infarct-Factor: The Case Study of Scopus Publications in Kazakhstan (Zhannura Manapbayeva)
- Education Service Digitalization: Lessons of the Pandemic COVID-19 (Olena Verenysh)
- Safe Exam Browser for E-Assessment in Learning Management System (Muhammad Anjum Malik)

Session on **Digital Transformation in Health** (Ingo Kregel)

- Quality Management in a Holistic Care Platform (Tim Krueger, Jelena Bleja, Prof. Uwe Grossmann)
- Industry 4.0: Role of IoT in Healthcare (Krishna Vaghasiya, Shreya Bose)
- A Study on Smart Wheelchairs: Improving the Quality of Usage for People with Mobility Disabilities in Smart Cities (Vignesh Somasundaram, Andreas Becker, Tien Tran)
- Review of Secured Methods for Implementing Unified Health Information Records and Proposal of a Health Recommender System (Heba Al Bizreh, Emmanuel Awoin, Mouhammad Zain Uddin)

Workshop “**Solar Car**” (Alexander Bokelmann, Matthias Drossel)

Session on **International Higher Education Cooperation and COVID-19** (Christine Beckmann)

- The Challenges for International Cooperation of the Peruvian Network for the Internationalization of Higher University Education: An Exploratory Study (Mariella Olivos, Sheyla Salazar)
- Transformational Competences for Internationalization Facing COVID-19 and Post-COVID-19 Scenarios (Yamila Fernanda Silva Peralta, Carlos Daniel Antenucci, Margarita María Guarín Acosta)
- COVID-19 and Teacher Continuing Education: The InnovaT Project Strategies to Support Higher Education in Chile and Peru (Ligia Franco Pasqualin, Liliya Terzieva, Carlos Alario-Hoyos, Carlos Delgado Kloos, Regina Ticona Herrera, Maria Maldonado)

Session on **Digital Transformation & Virtual Education** (Moramay Ramirez)

- Strategies to Face the Challenge of Virtual Education (Ema Elena Aveleyra, Melisa Alejandra Proyetti Martino)
- A Dataset on the Digital Transformation of University Courses During the COVID-19 Pandemic (Ángel Carrión-Tavárez and Javier Gutiérrez-Ballivián)

- Digital Transformation and Its Implications for Latin American Universities (Lourdes Maritza Ortiz Sosa, Gisela Carrero Morales, Vanesa Santiago Ríos, Grace Di Leo, Mariela Camargo Román, Mariella Olivos)

Saturday, June 26th:

Video Session

- Software Implementation of Methods for Object Recognition at Production Site (Yurii Shemberko, Elina Tereschenko, Natalia Myronova)
- Development of Project-based Organisational Structures to Respond to VUCA Environments (Markel Delgado Valcárcel, Francisco Sánchez Fuente, Jose Ramón Otegi-Olaso)
- Transformation of Labour Potential in Dimension of Digitalization Economy (Oleksandr Levchenko, Dmytro Plynokos, Ilona Tsarenko)
- Health Monitoring for Diabetics with a Software-Intensive Solution (Farhad Saadatjouy Asr, Saadiya Damani)
- Student Journey Configurator Prototype: An Application of Usability Engineering Concepts (Krishna Vaghasiya, Fatemeh Moradian Tehrani, Shreya Bose, Sabit Shaikholla)
- FHydrate – Prototyping for Sustainable Tree Watering in Public Area (Sedat Akar, Daniel Azbel, Torben-Eric Jesser, Elisabeth Schulze-Hulitz, Prof. Dr. Dino Schoenberg)
- Development of a Time-of-Flight 3D and Polarization Camera for Automotive Applications (Ladan Alaei, Michael Karagounis, Thomas Rotter, Andreas Pile, Felix Schneider, Remzi Karaarslan, Jitikantha Sarangi)
- Biomedical Applications with the Usage of Virtual Reality (Daria Trunova, Galyna Tabunshchuk, Peter Arras)
- Architecture of Intellectual Information and Training System (Assel Smaiyil, Abu Kuandykov, Marco Brambilla, Zhibek Sarsenova)

Workshop “**Project Management Research and Practice Journal**” (Beverly Pasian)

Keynote Speech “**Project Management Data Analytics Lab**” (Nigel Williams)

Session on **Project Management** (Olena Verenych)

- Leadership in Application of Agile Project Management Methodology (Sergey Bushuyev, Natalija Bushuyeva, Denis Bushuiev, Victoria Bushuieva)
- Success-Oriented Structured Model of Managing International Development Projects in Ghana (Barrister Kenneth Appianing Asomaning, Vladyslav Dombrovskiy, Okyere Philbert Aboagye, Iryna Turchenko, Mykhailo Dombrovskiy, Anatoly Sachenko)
- Cost Overruns in Infrastructure Projects: A Review. The Case of the Spanish Construction Sector (Guillermo Alonso, Francisco Ortega Fernandez, Pablo Nistal Diaz, Ana Fernández Iglesias, Henar Morán Palacios)
- Overview of PhD Research in Convergent Knowledge Management in Multinational Projects (Olena Sharovara)

- The Relationship Between Project Managers' Leadership Style and Project Success (Mahboobeh Ramezani Farokhad, Ala Nuseibah)

During the Conference, a consideration has been given to further development of other events, including next year's IRC, into a hybrid format, in which the elements of the online version are implemented in the on-site event. This will make it possible to involve even more researchers and partners in the collaboration.

We say thank you to all authors for the contributions to the Dortmund International [Interactive] Research Conference 2021. The contributions are important – as well as the discussions – for the evolution of the community and the growing power to meet the requirements of the future.

Greetings from the flow of strong projects!

Christian Reimann, Carsten Wolff, Stephan Weyers, Mariella Olivos & Team

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IF WE WERE THE RULERS OF THE WORLD. PART III: GUIDELINES OF A PROJECT TO PROTECT THE WORLD

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Abstract: *We ignore that we destroy our world in these decades of the last 200 years. “The world was empty before – now it is full” stats the Club of Rome because the overpopulation leads to the problem that we have to use all fertile land to live on or to produce food for us. This Part III (of IV) of this line of articles deals with the leading rules how to manage such a project to save the world. Without democracy nothing will change on this world because we have to care about piece, freedom, balanced power without violence and force. We need a lot of new rules to make such a project happen like changes in a long perspective only and starting step by step.*

Part I deals with the reasons to start a project to protect the world. Part II of this line of articles deals with the areas we have to care about on global level. Part VI shows how this project really can start and who can and should initiate it in which way.

Keywords: protection of the world, environmental protection, climate change, overpopulation, deforesting, bio diversity, pollution

1. Introduction

This part III of four articles is based on the already described need of acting and the already described areas of political tasks on world level. We all know that we should care more about the world not to destroy it (part I) and we defined the 15 areas of politics where a global approach is needed (part II).

In the following chapters of this part III we derive several rules from general basic values of behavior. The aim is to define side rails for this project to save the world from us as human being. The following suggestions for solutions are presented for current and future problems with no regards to the political tasks itself like stopping climate change or overpopulation. They ought to be general and leading to success regardless of the specific objective. They describe how to achieve strictly the targets on world level like combining unmet tasks with sanctions, being strict in the target itself but starting step by step nation-wise and also step by step task-wise or - as another binding rule - not to allow exceptions.

2. Rules to Be Successful to Protect World

Before starting with detailed project rules it is needed to call democracy as the covering rule above all others. We know from books, history and movies the idea of dictators trying to take over the leadership of the world. Sustainability, freedom and respect for people can only be achieved by participation all people in opinion making. In Part IV I will show that the initiation of the project to protect the world will not come from the voters, because they tend to vote for themselves and their own needs. So Initiation and preparation has to be taken over by others. But democracy has to carry the project to every nation and democracy has to carry the project itself.

2.1 Basic Principles of a World Leadership

The first principle is easy to derive from our own lives. Do unto others as you would have others do unto you! This rule helps immensely. Everyone has to take care of their own problems in agreement with others, at least they should do. This includes a mutual "live and let live" principal, such as preventing the exploitation of nature and the environment. This should characterize our behavior as a whole and on a sustainable basis.

If one dislikes these and similar principle rules, one will not find any joy in the following explanations for they will be restrictive.

Principle number 1: "Do unto others as you would have others do unto you": We can no longer dispose of waste on our neighbors' land, no longer eradicate our neighbors, no longer use more material that can in the same time be renewed.

2.2 Organizational Limitations

In my view, systems of democracy, competition, consumption or general development are indisputably the way forward. However, there are dictators and dependent economic systems that want to stick to the past. Also, this might be part of the freedom and tolerance of a democratic state. If for example the activities of whaling or waste dumping in the sea are accepted by the majority of the voters, this will be democratically established and will certainly make sense for the individual state. But if one is the leader of the world, then one can show no tolerance for the regular use of atomic bombs or the dumping of waste in the sea. The principles of freedom must not harm anyone. My professor of economic policy during my studies in Dortmund insisted upon his point of view that the "wise dictator" was the best solution for the world. I agree with him to the extent that it works, but would his successor be wise? Or the third dictator in succession? Just as communism is an ingenious model that does not work with us humans, I think that only democracies can go the right direction: free, equal, sustainable (not yet unfortunately), welfare and future oriented.

The organizational tool of "democracy" is exercised in traditional structures in individual countries. In the past the horizons were more limited, but today we all feel closer to each other, the infrastructure, problems, and opportunities for action have all become global. However, organizational structures are still oriented to a national level. The UN is heading in the right direction, but is perhaps on the third of around 20 potential steps: so sustainable world policy in the really important areas in combination with assertiveness is still missing. Also, the EU remains half-way through the process; no one wants to let go of their individual influence completely.

Looking at topics such as "taxes" and "education", harmonization may be useful, but competition is probably even more workable. Is the neighboring country able to cope with lower taxes and still provide a perfect infrastructure? Why not allow competition in the tax systems of countries? Why not allow competition in education? Competition (and at the same time freedom) of systems, business, workers and religion is an optimal solution. For this, national boundaries need not be crossed.

But issues such as global warming, environmental pollution, exploitation of resources or the destruction of species are global issues. They concern only one "organizational unit": the world as a whole. Our waste, which we deposit on our neighbors' land, is returned to us - either by way of them throwing it back in our direction, or in the case of exhaust fumes, they blow around the world and come back to haunt us. We all know this, only the effects are so small that no serious action is pushed as yet. We have to act! What would have become of Hitler's Germany if the Allies had not intervened? Why is the US still militarily intervening today? Because it assumes

responsibility for the world, and there is no globally functioning organizational unit for world peace. I believe the US role in world peace is not to be underestimated. Of course, this US policy is also used to support self-interest (oil?) or to distract from domestic political problems.

In short: any of the following points and problems requires global solutions. Some things can be sorted out at home, while others must be solved bilaterally or multilaterally in the neighborhood at large. And for some wider issues you will certainly need a mayor with strength and who can take responsibility for the whole.

Principle number 2: The world powers should agree on a meaningful organization: Global issues need to be solved globally. Environmental protection, world peace, protection of biodiversity must be handled and solved globally at a binding and responsible level.

2.3 Focus on What Is Important

Managers and politicians tend to process the most urgent topics.
What does the press write about me? Great attention to that!
Where is the crisis? This is what must be taken care of!
Which elections are in front of me? This is in the foreground!

Instead of constantly solving urgent problems (Ukraine, Greece ...), the leaders of the world powers should be guided by important things. Eisenhower had already recognized this and Stephen Covey developed it further. I will briefly summarize Eisenhower as follows: managers, companies, politicians and leaders and all other ordinary people who want to get their lives under control: deal only with the most important things and do so carefully, then everything will turn out fine. No time should be wasted with unimportant things. The unimportant things should be delegated if possible or omitted completely. And do the important things early enough so they won't become urgent.

Instead of this approach, urgency is often celebrated by waiting until known issues become a problem. For example, why do we wait for an energy revolution, when we know that in around 300 years there will not be a drop of oil left and even the coal will be consumed? And if it is not 300 years, then maybe it will be 500. The point is that they are finite, and it is important to solve these problems now, not when our grandchildren are in climatic distress because we have lived lavishly without fully using our technical, scientific, logical and political capabilities. It is highly important for the world to choose the issues that must be addressed and that would bestow a high regard upon us from the point of view of our grandchildren. So far, the world's elite has been concerned with those things that a secondary level of leadership should do: solving crises, creating laws, holding official welcomes and so forth.

Principle number 3: The world's elite has to be concerned with important and sustainable matters, such as the fundamental organization of the world and the solution of multi-generation problems.

2.4 The Time Frame of a Decision

It's easy to make demands and to expect implementation "immediately". But let's be honest, how can we end every war immediately and restore every river? Compliance and implementation usually take time. This is absolutely necessary. A second reason for the time delay is our own inadequacy. Who is already in the position to assert politically that gasoline must be dispensed immediately? But if we have more realistic deadlines in mind, it is likely that the decision makers are more willing to say "yes", perhaps because the problem will then be passed on to the next generation. The time lag between decision-making and implementation is one of the most

important aspects of problem-solving. One should not discuss the irrefutable necessities, rather the period of time for implementation. The Kyoto agreement was not entirely misguided in this regard (setting long-term goals, otherwise unenforceable), but it was not consistent enough in terms of content, and perhaps set too short a time frame. Better to solve the problem completely in 50 years' time (and only "completely" is the right solution) than to decide to do so after about 20 years, when we are now still using such large amounts of CO₂-containing fuels. The negotiation should not be conducted about the solution itself (which is always simple and clear, see next chapter), but on the subject of time. It would be better to add a decade and then reach a consequent solution of the issue. A third reason for the time delay is the duration of industrial equipment and technology. For example, people buying a new gas heater today are unlikely to accept that gas will no longer be allowed tomorrow. One wants to use this method of heating for at least 20 years. Thereafter a new heating system is certainly due, which might then be a totally different type of technology – this way seems acceptable.

Principle number 4: Be clear regarding the goal itself, but make things compatible and realistic with specific time limits: It is better to achieve the goal after 50 years than never.

2.5 Problem Solving Must Be General

Any resolution at the highest level seems to me to be quite simple (for example, no waste in rivers, no wars), such as a constitution of a state is quite simple and general (for example the dignity of all men is inviolable). The problem in each case would be the specific design. But what is missing in the world (that is our highest organizational unit) is a kind of global constitution for resolutions at world level.

Principle number 5: Problems must be resolved in general. Based on this, there will be no great discussions about "special exceptional rules" or doing things by halves. The truth is always quite simple.

2.6 Separation of Preparation and Decision

The heads of governments in the world all have their own specific, nationally-oriented issues and the greater goal is lost sight of. The solution should be to create internationally-engaged recognized expert groups (consultants, scientists, leaders of appropriate organizations ...) who identify the right areas and define it in terms of targets and individual solutions.

Principle number 6: Carefully designed, logical resolutions without compromise and without special exceptional solutions are to be formulated by expert groups.

We have to define the principles beforehand. These are relatively simple: "Expert groups: please formulate well thought-out and sustainable concepts, about which our descendants will be able to say, "After hundreds of years of selfish generations and countries, a change took place, and from then on a new era began: the one of sustainability." "

Principle number 7: Before the work begins, general principles must be provided to the expert teams which must be so simple and uniform that no dispute could arise.

Contents: a) No special rules - individual states are never explicitly named; b) No half solutions, if something is bad, then it must be completely rejected; c) No political solutions - only consistently developed solutions may be devised; d) Sanction mechanisms shall be drawn up; e) Milestones shall be defined en route to the overall objective.

2.7 Sanctioning Mechanisms

It is not enough to merely set the expert groups more or less on track and it is not enough to make the rules binding through a state or the UN. There must also be control of target attainment and compliance. Sanctions should not be made arbitrarily or retrospectively, and should be capable of being withstood by individual states. International funds should now be created to which all (according to GDP/inhabitants) must contribute. The milestones described in the next chapter can serve as success points. Tranches of the fund must then be saved for ten years for example, and then paid back to those who have achieved specific defined objectives relating to these milestones. The ideal scenario would be if everyone got their money back, as everything had been implemented exactly as planned. Until the final implementation date (for example in 50 years), money will be collected for 50 years and then repaid ten years later. If concrete goals are not achieved, the money will be paid to those who are already accomplishing higher achievements of the goals, all this without political games and excuses.

Principle number 8: Logically thought-out and functioning sanction mechanisms are to be established, which no longer depend on personal conversations, but on independently ascertainable goals.

2.8 Milestones

The expert groups should define milestones on the way to the overall target. This makes the process of implementation operational and controllable as well as making sanctions possible.

Principle number 9: The expert group develops factually logical, achievable and measurable goals for the final achievement of the objectives and their respective milestones.

2.9 Selection of the Participating States

We all know that we can only take care of superordinate matters and strategic or joyful things when we are well-fed and have a roof over our heads. The community of nations necessarily has to be divided into groups. States that consider themselves stable, those who can feed their population, all who can raise their heads high enough to think about the future, should participate. One of their tasks will then be to support the states which have not yet participated, to help to pacify and develop them. This is one of the important measures that must be taken by the world's elite. So, at first not all states will be able to participate in the same way. There will also be states that want to subjugate their populations and do not care about the rest of the world, since dictators do not want to give up their power structures, their corruption or financial interests. The community of states must assume more responsibility for these states too. At the end of the process the solution to the problem can only be achieved with the participation of all.

Principle number 10: At the beginning, the states that do not want to or cannot participate are to be separated. Complete harmonization from the outset appears to be impossible. The states which do not participate must be distinguished as being in need of assistance or dictatorial, and different strategies and sanctioning mechanisms must be worked out accordingly.

2.10 Building the Concepts – Project Rules

The concepts to be developed must be designed in such a way that immense work is invested in preparation, logic and planning, which then ensures that there will be no disputes later. Concepts must be: a) well prepared, b) logical and intelligent, c) cannot cause any dispute at the end, d) be acceptable for all parties from the start, e) additionally be transparent and comprehensible in terms of all the consequences entailed, f) the parties should be on equal footing and if necessary a

solution could be found "with the flip of a coin", which should not lead to disadvantages for the individual, g) the concepts should definitely bring about a solution without further disputes, h) risks should be anticipated and reconciled beforehand, and i) non-action must be subject to sharp and known sanctions, whereby the concerned party must no longer have to agree or do anything. This must all be made clear beforehand.

Principle number 11: The following concepts are drawn up according to the above-mentioned rules. If all points are fulfilled, then only the rule must be voted on or introduced. Preparation and planning are therefore to be observed very closely, as they would be in any normal project management.

3. Closing

To start a project to protect the world against ourselves needs some project rules to be able to handle the situation, that we are humans – that we don't want to act if it hurts – that we like to postpone things – that we sometimes need penalties and so on. On the other hand we cannot start with all countries in one moment and we need a very pragmatic but working solution for such a project. In Part IV I describe who - and in which steps - could start the project. This part III is dedicated to the applicable rules to be successful and get the ok of the world's human being. To summarize: we will not be successful if we want to start immediately, with all nations and in all areas. Important is however that we start a consequent concept and build it up based on democracy, worldwide and with the needed organizational structure.

THE CONCEPT OF THE PROJECT AND PROGRAM PORTFOLIO MANAGEMENT METHODOLOGY IN INTEGRATED FUNCTIONAL ENVIRONMENTS

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Abstract: *Authors consider that project management methodologies have its own set of processes and principles that are common to most of them. To determine the concept of methodology for managing portfolios of projects and programs in integrated functional environments, a model of the concept of managing portfolios of projects and programs of a project-oriented enterprise in a functional 4P-environment was proposed. This model consists of three planes: the plane of project and operational activities of the enterprise, the plane of programs and object-resource components, the plane of project and operational production. The implementation of pilot projects has shown that the use of methodology of project and program portfolio management in integrated functional environments allows more efficient, reliable, error-free management of a significant number of projects of project-oriented enterprise.*

Keywords: integrated functional environment, 4P-environment, project management methodology, project and program portfolio management

1. Introduction

Today's period of development of Ukrainian business is characterized by many crisis phenomena, the way out of which requires an increase in the number of various projects in all sectors of the economy. Projects and programs portfolios are formed at enterprises, which require coordination of work performance and use of resources, clear executive discipline, combination with enterprise development strategy, comprehensive control. Various software tools are used to manage project and program portfolios. But the processes of managing projects and programs portfolios are more closely intersected with the activities of the entire enterprise than with the management of individual projects or programs. Therefore, there is a need to create a single functional and managerial environment, which includes both project and program management functions and enterprise management functions. A new organization of operational and project management processes as a single system of management functions implemented in an integrated functional environment is needed.

Understanding the need to create a single system that will be an add-on on the existing project and operating environments of the project-oriented enterprise and combine them into a single whole requires a change in approaches to project and program portfolio management and project-operational production in the direction of its consideration as a system activity. From these positions, issues of conceptual, methodological and methodological nature remain unresolved. Based on the analysis [1-8], each of the considered project management methodologies has its own set of processes and principles that are common to most of them. Nevertheless, all these processes are considered separately from the functional and information space of the enterprise. None of the existing methodologies is focused on the application in the integrated functional environment of the project-oriented enterprise, which would combine the functionality of software and people in the project and operational activities of the enterprise [9].

Existing project management methodologies require "breaking" the work of the organization, restructuring all its activities. This approach is more expensive and requires a change in organizational culture, which takes a long time to implement such a methodology in the enterprise. Authors offer to consider such approach which without changing the existing organization adds the system which unites project and operational activity in a unified whole. The lack of such an approach is a cognitive imbalance in the science of project management.

2. Paper's Purpose and Objectives

The paper's purpose is presentation of the concept of methodology of project and program portfolio management in integrated functional environment of the project-oriented enterprise.

Objectives of the paper:

- to develop a model of the concept of the projects and programs portfolio management of the project-oriented enterprise in the functional 4P-environment;
- to show a practical implementation of the methodology of project and program portfolio management in integrated functional environments.

3. The Concept of the Project and Program Portfolio Management Methodology in Integrated Functional Environments

Methodology of project and program portfolio management in integrated functional environments is a system of conceptual provisions, models, methods, tools, regulations for the integration of portfolio, project, program management functions with operational management.

Integrated functional environment is an environment in which functions are integrated:

- presentation of products of portfolio projects in object-resource components;
- determining of one-time technological processes for the manufacture / procurement of object-resource components;
- determining the sequence of one-time technological processes for obtaining products of portfolio projects, taking into account their prioritization.
-

An integrated functional environment combines the functions of the project and operational activities of a project-oriented enterprise, which must be managed as a unified whole.

The functions of project activities are implemented in the process of managing of the project and program portfolio, and the functions of operational activities are included in the processes of operational and production work of the enterprise. At the intersection of project and operational activities, project and production processes can be implemented, the functions of which must also be included in the integrated functional environment [10].

The purpose of the project and program portfolio management methodology in integrated functional environments is to increase the efficiency of project and program portfolio management by creating a single integrated functional environment that will combine project and operational activities of project-oriented enterprise into a single system (Fig.1).

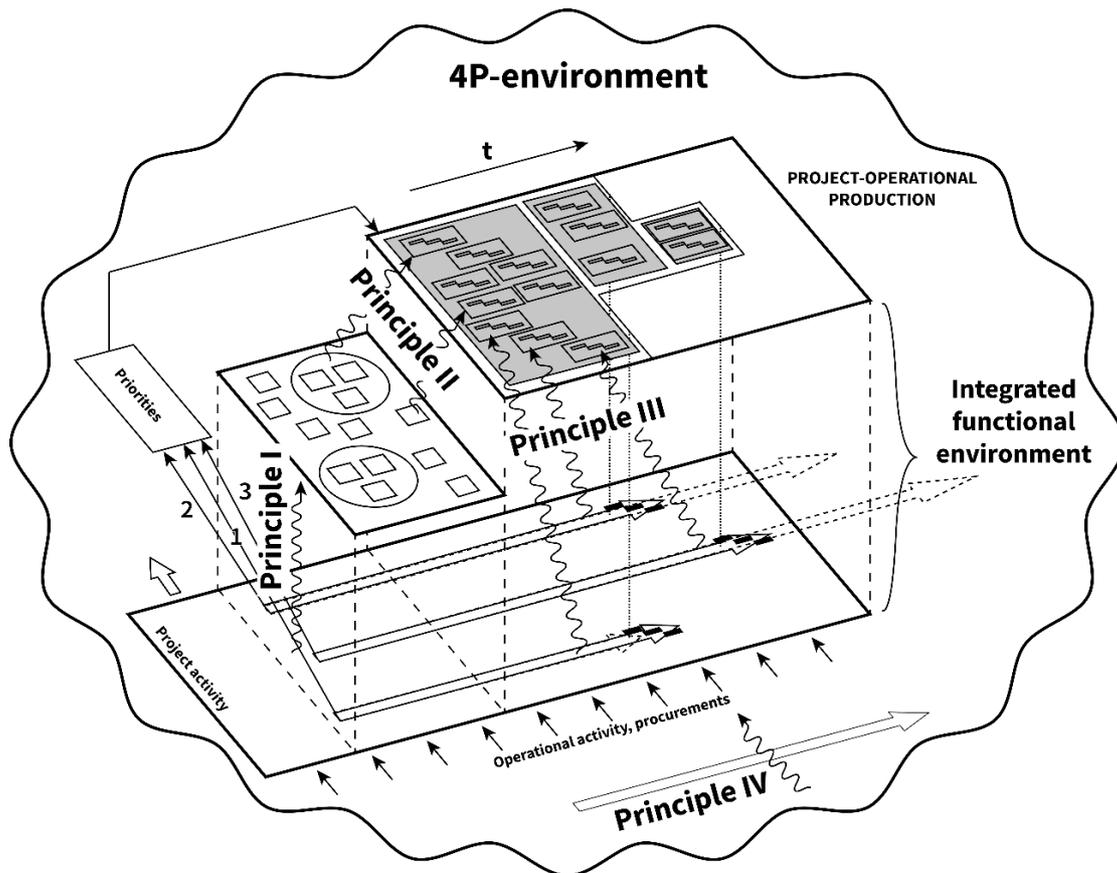


Fig. 1. Model of the concept of the projects and programs portfolio management of the project-oriented enterprise in the functional 4P-environment

This model consists of three planes:

1. The plane of project and operational activities of the enterprise.
2. The plane of programs and object-resource components.
3. The plane of project and operational production.

On the plane (1) arrows show projects that start at different points in time. Dotted arrows indicate how projects were implemented before the implementation of the project and program portfolio management methodology in integrated functional environments. Projects after the implementation of the methodology are shown with a solid arrow. In addition to project and operational activities, the company may also have separate operating activities, the result of which is also indicated in Fig.1.

Each project has its own priority, which affects the production of products for projects. The plane (2) of programs and object-resource components is a technological plane, which reflects how the products of projects are presented in object-resource components.

The plane (3) of project-operational production reflects the process of production of object-resource components, namely:

- definition of one-time technological processes for the manufacture / procurement of object-resource components;
- determination of the sequence of execution of one-time technological processes for obtaining products of project portfolio taking into account their prioritization.

At this level, there are no more projects, as unified parts are produced, which can be produced in the quantity needed to support the projects, or in another quantity depending on the results of modeling the production plan. And in this case, when the figure shows three projects, the production first envelops all three projects, then only two, then only one project, which is shown using gray rectangles.

When the production reaches the stage of production uniqueness for each project and the assembly of the finished project results, we go down to the plane (1) again.

All three planes are an integrated functional environment. The figure also shows the 4P environment, which includes both the integrated functional environment and the external environment of customers, which affect the prioritization of projects.

The principles of the methodology of project and program portfolio management in integrated functional environments are offered: the principle of integral consideration of portfolio projects of project-oriented enterprises, the principle of one-time production / procurement of one-type and identical object-resource components of projects, the principle of prioritization of one-time technological processes, the principle of openness of the project portfolio.

These four principles also designated in Fig. 1.

4. Practical Implementation

Practical implementation has shown the achievement of economic effect from the use of the methodology of project and program portfolio management in integrated functional environments through experimental and industrial usage of project portfolio management tools developed on their basis [11-13].

A study of the effectiveness of the use of project management tools in the 4P-environment on the basis of a functional add-on in the management of the portfolio of aircraft manufacturing projects was conducted. At the time of the study, the portfolio contained 12 projects. Among them, 5 projects have been completed, 4 at the implementation stage (2 less than 50% and 2 more than 50%), 3 projects at the initiation stage. In addition, 8 projects related to the repair and modernization of previously manufactured aircraft were implemented. In total, the projects contained 1201 works on the assembly of aircraft components and the aircraft themselves. The total number of different types of components was 1965. Labor works for project work ranged from 1 to 1116 hours. The number of products per 1 aircraft reached 1772 (rivet 3.2x6 DIN7337). It is clear that in these conditions it was very important to calculate the number of parts produced, taking into account all the projects in the portfolio, as well as using the forecast of new projects. Therefore, simulation modeling of the process of manufacturing parts and assembly of the aircraft with existing manpower was of great importance.

In Fig.2. the part of details which were made in other projects of a portfolio is shown. As can be seen from the figure to the project 5, part of these details increased. By projects 6-9 it decreased. This is due to a new modification of the aircraft, as well as a significant gap in their manufacture over time (it became unprofitable to store a significant number of parts in warehouse). And the projects 10-12 were initiated after the approval of the details release plan (in the course of other projects). Therefore, the surplus of previously manufactured parts was forward to them, which was partly explained by forecasts of new projects, as well as adjusted the production plan for projects that were still manufacturing parts.



Fig. 2. Part of the details that were made before the project beginning

As a result of such modeling, a plan for the production of details in the project portfolio of Carbon Invest LLC was formed. Based on current information on the actual production process for all projects (aircraft production, repair, modernization), the number of products manufactured without reconfiguration was 15.5% (485 out of 3133), which reduced the time of aircraft production by 13.8%.

5. Results and Conclusion

Analysis of literature sources on existing approaches, concepts, models and methods of integrating project management tools into a single system for portfolio management has shown that the main methods of portfolio management of projects and programs are: implementation of PMO, development of project portfolio management standards, application of project portfolio management tools, as well as methods for selecting projects in the portfolio. Portfolio management is based on the use of information and communication technologies, the functions of which together with the functions of methodological and organizational tools of the project-oriented enterprise form an integrated functional environment. The integrated functional environment combines the functions of the project and operational activities of the project-oriented enterprise, which must be managed as a whole.

The concept of project and program portfolio management of a project-oriented enterprise is proposed, which is represented by a system model consisting of three planes: the plane of project and operational activity of the enterprise, the plane of programs and object-resource components, the plane of project-operational activity. The defined planes are interconnected by the purposes, principles, tools and the conceptual apparatus of the developed methodology. The developed concept allowed to pass to creation of models and methods of methodology of project and program portfolio management in integrated functional environments according to the formulated concepts, principles, structures and approaches.

The implementation of pilot projects has shown that the use of methodology of project and program portfolio management in integrated functional environments allows more efficient, reliable, error-free management of a significant number of projects of project-oriented enterprise.

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THE CONSIDERATION OF SUSTAINABILITY IN PROJECT MANAGEMENT AND TECHNOLOGICAL INNOVATION FOR ORGANIZATIONAL STRATEGY

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Abstract: *Sustainability is important for an organization to achieve a long-term impact. The integration of sustainability into project management and technological innovation is a new trend for organizations to change from traditional organizational strategy of profitability to sustainable organizational strategy, which enhances competitive advantage. The study aims to provide a clear understanding of the sustainability concept, how it fits into project management, and how it can enhance efficiency. Also, it examines how sustainability in project management and technological innovation can help in attaining sustainable organization strategy. The research uses a systematic literature review, case study, and interview as a means of data collection strategy. The paper chose an organization (Company A) using purposive critical case sampling; the case was developed using data sources from critical incidence techniques, interviews, and documents collected from the organization, including a public source, e.g., the company website. The interviews are transcribed, validated, and analyzed by interpretation, content analysis, conversation analysis of the information provided. The study proposed a model for sustainable organizational strategy and a working definition of sustainable project management. The analysis reveals that competitive advantage can be achieved by integrating sustainability into all areas of operations, especially project management and technological innovation. It also showed that sustainability is about creating value, and the integration is capable of organizational development and an increase in profitability. Lastly, the integration of sustainability has a significant impact on the organization: it enhances synergy in the organization, improves organization competencies and organizational governance.*

Keywords: project management, innovation, sustainability, organizational strategy

1. Introduction

The definition of sustainability depends on the strategic view of the organizations. It might be going green in the activities, products, projects, and operations of the organization. Additionally, it means the capacity of the organization to endure and sustain itself from the pressure of changing market demands [1]. These days, the concept of sustainability is essential and cut across all operations of an organization. In 1987 during the world commission on environment and development, the relationship between projects and sustainable development was first introduced [2]. The need for sustainability to be included in project management can never be overemphasized [3] as project management itself is a strategic concept for organizational growth. On the other hand, technological innovation is vital for improvement in how we utilized resources and also for strategic economic growth and development [4]. Technological innovation is highly important and crucial for competitive advantage, and technology strategy is what an organization uses to determine its long-term existence and ability to handle the threat and opportunities within the external environments. Also, government regulations and policies are essential factors for technology strategy as these affects how the organization form and reform their approach due to these factors.

There is a misconception that organizations that focus more on sustainability are not competitive. Also, not profitable compare to other organizations [5]. This is because the concept of sustainability is perceived as a hindrance to some organization because the concept come with dos and don'ts, e.g., reduction of CO2 emission, production of sustainable product and regulations etc. According to [6], the authors reviewed six pieces of literature on the theme of technology, innovation, and sustainability with different geographical locations. It was concluded that none of the reviewed articles examines the social criteria or dimension of sustainability and the author further explained that the social aspect of sustainability is still not adequately investigated. Although some organizations still use the traditional philanthropic approach for social contribution, this is limited as it only increases public branding of the organization and does not conform to the original aim of sustainability topic. [2] concluded that the required competencies and skills needed to implement sustainability in project management still need more research and study, as this makes it difficult and challenging for individuals and organizations to implement the topic of sustainability into their day-to-day business operations. A lot of researchers have proposed a matrix and dimension of sustainability; there is a need for a simplified model or approach that will make the integration seamless for implementation as the integration is not fully recognized and not well understood [7]. The awareness of social, economic, and environmental issues into technological innovation is a strategic tool for organizational development [8]; this is not enough as no model or approach critically suggests how to integrate the issues of sustainability into the technological innovation.

The study aims to provide a clear understanding of the sustainability concept, how sustainability fits into project management, and how it can enhance organizational development and efficiency. The paper also intends to provide a proper understanding of technological innovation, technology strategy, and sustainability. Examine how sustainability in project management and technological innovation can help in attaining a sustainable strategy for organization development.

The primary and critical research questions for this research paper include: What are the challenges of integrating sustainability into project management? How does an organization perceive sustainability and its influence on project management? How can sustainable project management practices and sustainable technological innovation lead to sustainable organizational strategy?

This research paper is divided into four sections, and the first part introduces the main idea of the projects stating the background of the study, research questions, and the research aims of the project. The second section is the literature review which discussed intensively and breakdown the components and the themes of this research; it includes sustainability in project management, technological innovation, and technology strategy. The third section discusses the research methodology adopted for this research and its analysis. The fourth section is the discussion of the result obtained during this research, conclusion with potential recommendations and suggestions for further studies.

2. Literature Review

2.1 Sustainability in Project Management

The topic of sustainability is becoming an essential concept among academia and business experts, and other stakeholders [9]. This concept gains recognition to tackle the challenges of meeting the present needs with the consideration of the future [10]. In 1987 during the world commission on environment and development, the relationship between projects and sustainable development was first introduced [2].

Projects are crucial and vital for the sustainable development of an organization as they are the main business of an organization[11]. It makes a strategic contribution to an organization's

sustainable development [12]. Therefore the idea of sustainability should be considered in projects and its management [13]. Some project management standards discussed the aspect of sustainability, but [13] concluded that the integration of these two fields is not fully recognized and not well understood. [14] suggested that there is more need for more empirical studies to give more clarity and understanding of how the topic of sustainability can be implemented and integrated into the field of project management.

Although the concept of integrating sustainability into the project has been worked on by many researchers proffering different standpoints and perspectives. Many researchers have proposed many dimensions. The following dimensions are common and surface from most of the literature review; Compliant [15], Transparency and Accountability [16], Stakeholders' engagement [17], and [18], Corporate policies and practices and organizational learning [11] and many more.

[13] use the term "depth of vision" to define the maturity model of sustainability in project management. The author analyzed and considered different stages for sustainability in project management. The model analyzed the level of resources, business processes, the way, and manner goods and services are being delivered, and the good and service itself. Considering these levels or stages at all levels of operations in an organization and backing it up with the issues of sustainability is one fundamental way to integrate sustainability in the projects and products of an organization.

2.2 Sustainable Technological Innovation

There is a need for technology innovation to be sustainable because technological change is the answer to social and economic demand. Innovation can be defined as the creation of something new (product or services) or improvement on an existing idea [19]. Innovation is essential for long-term economic development [20], and it seems to be a connection between innovation and sustainability [5]. Technology innovation is perceived to be how technology breakthrough is achieved. According to [4], the process of creating and developing something (product, ideas, services, functional and quality of life or product) by introducing and applying the latest knowledge, methods, processes, and technology refers to technological innovation.

Sustainability is the consideration of the three pillars in its area, therefore for technological innovation to be sustainable, it is crucial to consider the economic effect, social and environmental effects on the new projects or ideas through technological innovation. The integration of sustainability into technological innovation takes into effect the three pillars of sustainable development.

2.3 Sustainable Innovation Project Management

For the organizational strategy to be achieved, project management plays an essential role in achieving the aims, objective, and process business turnover. A project is defined as a set of specific activities to achieve objectives within a limited timeframe, and it also involves the consumption of resources to achieve the objective. Project management is the application of tools and techniques for the management of human and material resources for project success. Project management can also be defined as controlling project objectives, using organizational resources [21] to achieve the project objectives. [22] concluded that the main element for sustainable project management is the commitment of the organization to sustainability, trained project managers, utilizing sustainable project processes for project management are essential while considering sustainability in project management. Innovation is about the development of a new product, idea, or knowledge. We can analyze and evaluate projects with many criteria and dimensions.

3. Research Methodology

The interdisciplinary nature of the research paper creates a need for a thorough and proper literature review [23]. The data collection method suits the research type, philosophy, and research strategy adopted in this research paper. This research paper conducted a systematic literature review (SLR) [24]; the approach is considered efficient and enhances transparency. A thorough review of academic papers on the topic of sustainability, project management, sustainable project management, technological innovation, and technology strategy intends to provide an understanding of these topics. The process of the literature review is in stages; the first stage includes a search of the term sustainability, sustainability in project management, sustainable project management from the web, especially on google scholar, IEEE journal, research gate, sage journals, and Elsevier journals this is because articles on this journals are peer-reviewed. The second steps include a careful examination of the article to ensure the context, aim, and contribution of the paper suite and align with the proposed research topic. More attention was given to the paper that examine the integration of sustainability in its concept and context. The same steps were repeated for the term technological innovation and technology strategy. The author selected 71 articles and academic papers using the research title, abstract, and conclusion. In the end, a total of 30 references was selected.

Another data collection method for this research paper is through interviews. A set of semi-structured interview questions have been designed and more suitable for the research approach since the approach of this research is exploratory. A thorough literature review guided this set of questions and answer the research questions. The use of interviews allows the researcher to gain more understanding of the context. The interview section was conducted with three participants (innovation managers, sustainability managers, and project managers). The interviews are transcribed and validated and are analyze by interpretation, content analysis, conversation analysis of the information provided.

In this research paper, the author considered the theme of sustainability carefully and technological innovation. Therefore, the author makes use of a case study to examine critically further the research questions. The author chose an organization (Company A) using purposive critical case sampling (Saunders et al., 2009 P.240) and also fulfill the author's criteria for selection. The company selected has sustainability and innovation as a strategic pillar of the organization. The case was developed using data sources from critical incidence techniques, data, and documents collected from the organization, including the public source such as the company website and the company blogs.

4. Results and Conclusion

4.1 The Consideration of Sustainability in Project Management and Its Challenges

The topic of sustainability is considered in organizations of the three respondents; they all agreed that the topic of sustainability is crucial and important for modern organizations. One of the respondents agreed that the topic is a strategic tool for sustainable long-term business and because the issues of sustainability are critical and need to be evaluated before implementing the projects. The three respondents also explained that the issues of sustainability are mostly considered at the initiation stage of the project, this is because, at the initiation stage of the project the expectations are drafted, which focuses more on the issues of sustainability, with the demand expectation from the customers at the initiation stage this help to keep track of the issue of sustainability throughout the project phases. The consideration of this topic at the initiation stage help in promoting the idea of making sure all the unit of operations consider the topic in their projects and activities, checking the viability and assess the impact on projects, businesses, and operations. One of the respondents also explained that the process is continuous across all phases of the project, but for now, it is mostly at the initiation stage, the starting point of the project.

The challenges for integrating sustainability into project management include project manager capacity and competencies, skills, [26], [2] perception of theoretical and practical consideration of sustainability topic [27], many dimensions and criteria for sustainability [28], and no single recommended and unified standards. The research participants also explained and stressed that the major challenges of integrating the concept of sustainability into project management include the different concepts, dimensions, and methodology and no proven standards or maturity standard that can help organizations and individuals to do sustainable project management. The participants recommended that a technological approach: this an approach that focuses more on the use of technology to provide a sustainable solution to the business. Another important recommendation is stakeholder engagement, and authorized bodies should take up the responsibility of streamlining the different methodologies and dimensions to viable and visible tools and techniques.

The research paper also examines the required competencies for project managers to implement the issue of sustainability successfully. One important competency is knowledge management. Although [2] concluded that there is still a need for more study to show the required competencies for the integration [3] concluded that there is a link between knowledge management and sustainability topics, the level of knowledge that the project team member possesses is pivotal and crucial to the project success. Bases on the research participants and their versed knowledge in sustainability, they identify the following competencies to be required for project managers. Strategic vision, Knowledge management, Interpersonal, intrapersonal skills, Benefit analysis Communication, Personal development, and open-mindedness.

4.2 Sustainable Technological Innovation

The research paper also considers the topic of technological innovation critically and how sustainability can have an impact on how organizations initiate and carry out technological innovation, and the organizational impact of sustainable technological innovation.

Technological innovation is serving specific business issues, and the impact of sustainability enables the solution to be scalable. Sustainability makes the intention and original idea of technological innovation to be clearer. Technological innovation includes the development of new products, ideas, or concepts to meeting people's needs and provide a business solution. The impact of sustainability on technology enables us to answer the question of why, what, and how to proceed with the initiative having in mind the economic, social, and environmental effects. Also, to integrate sustainability into technological innovation, a clear key performance indicator essential this helps define and shape the selection gate for technological innovation. In other words, a checklist that shows that the economic, social, and environmental issues are being evaluated and monitor. This, in the long run, ensures that the primary reason for carryout the project.

Sustainable innovation Technology strategy: for technological innovation strategy to be sustainable, it involves two approaches: Top-down, i.e., the concept and the initiative has to start with the top managers, which is not just involving the issues of sustainability when the project is almost ready but a strategy in which is built into the culture of the organization by the top management, the senior management is responsible for making sure the initiative becomes organizational culture. The second approach is a bottom-up approach, the bottom-up, which includes creating awareness, people management by creating new business opportunities, empowering the people, working together with the local ecosystem. As mentioned before, a strategic KPI is important. For technological innovation strategy to be sustainable, a clear KPI (economical, environmental, and social) need to define; this serves as criteria to monitor and evaluate the impact of the strategy, organizational learning, and culture need to be revised.

The integration of sustainability into technological innovation has huge and numerous impacts on the organization, it impacted the synergy of the organization: technological innovation involves the collaboration within and without the organization ecosystem and involvement of different business units and department in which the integration fosters the cooperation and engagement. It also enhances organizational competencies, decision gate for technological innovation project and maturity level, organizational governance, portfolio management, the integration will also influence sustainability standards across all level practices.

4.3 Organizational Strategy Through Sustainable Project Management and Sustainable Technological Innovation

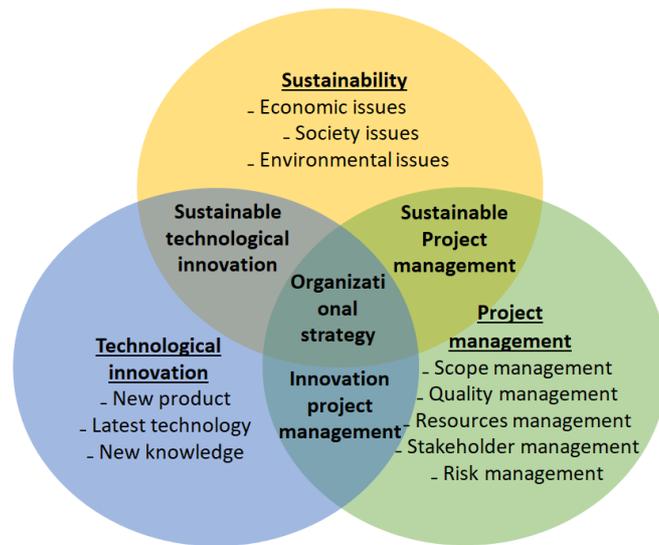


Fig. 1. Model showing the relationship between sustainability, project management, and technological innovation

The topic of project management, sustainability, technological innovation is very important for organizational growth and development. These three topics are key and important for the decision-making and strategy of an organization. After careful examination of sustainable project management, sustainable technological innovation, and innovation project management, a framework was developed by the author that shows the relationship between sustainable technological innovation, sustainable project management. For the organizational strategy to be achieved, project management plays an essential role in achieving the aims, objectives, processes, and business turnover. Technological innovation is vital for improvement in how we utilized resources and also for strategic economic growth and development [4]. [29] concluded by defining technology strategy as the decision of selecting a portfolio of projects that require commitments of resources and a process of accessing if the projects meet the organizational strategy. With all these elements, it is obvious that for an organizational strategy to be achieved, careful consideration of technology innovation and effective project management coupled with the consideration of sustainability will lead to effective and effective organizational strategy. Organizational strategy is the main activities and the actions an organization takes to achieve its vision, mission, and objective; the research proposed that organizations should use the concept of integrating sustainability into project management and technological innovation for competitive advantage and sustainable organization strategy.

4.4 Conclusion

The research paper postulated a framework that shows the strategic relationship between sustainability, project management, and technological innovation. The framework shows the new

and sustainable dimension of organizational strategy, which includes the consideration of social, environmental, and economic issues into project management and the initiation, development, new idea. Knowledge and new product technological innovation). Although the model backs some deepening in the different spaces between the concept as an organizational strategy depends on many factors within the organization. If an organization lacks expertise in one or more of the dimensions of the model, it will be difficult to implement the model as a working solution for organizational strategy. Also, the model will be difficult for the industries that make use of technological innovation, e.g., services providing organization (banks, hospitality, etc.), as the scope of the model is limited to industries that develop technological innovation.

Technological innovation is serving specific business issues, and the impact of sustainability enables the solution to be scalable. The integration of sustainability into technological innovation has huge and numerous impacts on the organization; it impacted the synergy of the organization: technological innovation involves the collaboration within and without the organization ecosystem and involvement of different business units and departments in which the integration fosters the cooperation and engagement.

After extensive literature review, a new definition is proposed for sustainability in project management: *The application of proper mindset (i.e., consideration of economic, societal, and environmental issues) to the way we coordinate, plan, organize, monitor, and strategize projects to ensure the present demands is met without damaging the potentials of meeting the requirements of the future and thereby increase organizational performance, increase profitability, increase competitive advantage and increase economic growth and development.* The research paper recommends that the consideration of sustainability at the initiation phase or stages for the project is essential; this stage includes the definition of expectations, creation of clear KPIs that will serve as acceptance criteria for the project, i.e., does the project satisfy economic, environmental and social issues. Also, since there are many methodologies, dimensions, and criteria for the integration of sustainability into the organization day to day operation, it is recommended to initiate a concept that strategically suits the pillar of the organization and be easy to implement the concept.

The paper also recommends that for organizations to maintain their competitive advantage is required for the organization to have a change in organizational strategy. The integration of sustainability into the way and manner projects are being managed and how new project are being developed and introduced to the market is the new trends for sustainable organizational strategy. The topic of sustainability is so vast, and a lot of researchers are working on the topic; many dimensions and criteria are making it difficult for organizations to implement the knowledge proposed by the researcher. Therefore, studies on how to unify and design an understandable matrix or standard is essential.

The framework postulated in this research paper needs careful and empirical investigation. Therefore, the use of project management and technological innovation for sustainable organizational strategy is an ideal topic for investigation. Another exciting area is the use of the shared value concept to measure the impact of sustainability can also be investigated.

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SUSTAINABLE PROJECT MANAGEMENT VERSUS RESPONSIBLE PROJECT MANAGEMENT: EVOLUTION OR COMPLEMENT

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Abstract: *Project Management research field is evolving in different dimensions and stages; in this study the idea is to analyze the similarities and differences of two research approaches that have been emerging mainly in the last ten years. On the one hand, the Sustainability in Project Management has been generating knowledge and studies in last ten years, establishing as a reference in academia world. On the other hand, Responsible Project Management, has started later but with the positive aspect of including more principles regarding the soft-skills of the project manager. In this context, this study wants to identify in which ideas these fields have similarities and in which ones they differ, to identify it is an evolution or if they are complementary fields.*

Keywords: sustainable project management, responsible project management, evolution, complement

1. Introduction

During last ten years, it has been a tendency in academia to integrate sustainability concept in Project Management. There have been different studies in order to identify the sustainability dimensions and in which aspects they will contribute to improve the project management performance. This need has been clearly identified by users and by policies trying to pushed the integration of sustainability dimensions in several fields.

While the academia was in the early development of this studies and experiments, in parallel, it has been defined Responsible Project Management, that at this moment is in a flourishing stage, but powerfully spreading.

In this paper it is going to be analyzed the evolution of both research fields, in the first two sections, each of the concepts will be separately studied. In the third section, there has been done a comparative analysis between the main characteristics and dimensions that each of the research fields are working and finally, in the last section there is a summary of the main conclusions.

2. Sustainable Project Management

Sustainability in Project Management was built by the integration of two concepts: sustainability and project management. During the last years there have been published several works and researches made about how this integration could be done. There are many researches oriented to find the best way to merge the sustainability concept into project management [1]-[3].

The first approach just focused into the Triple Bottom Line (TBL) [4]-[5] that considers just three aspects: People, Planet and Profit. The TBL proposal was enough in the first steps of the integration; but as the development of this research area advanced, there were new dimensions added. The team headed by Gareis [2] established a new set of the dimensions that consider the TBL and completed it with three new dimensions: short/mid/long term; local/regional/global orientation and value orientation.

At the beginning of the integration process, there were identified several complications due to the natural aspects of each of the concept: sustainability and project management. For instance, sustainability and sustainable development is oriented to long term aspect, while project management in short term oriented.

The main differences between the two concepts where in deep studied by several authors [6] and there are also studies that focus to identify the inter-relation between sustainability and project management field [7].

Till year 2016, as it was referenced by Mauro Luiz Martens [8] the integration of sustainability dimensions in project management has a lack of research. In last five years, there has been established the base concepts as there are many working group analyzing [9], [10] and studying how this combination of concepts could be performed; but still one of the pending topics is how to build the necessary bridges to develop this integration from the academia context to the practitioners. Indeed, there is a clear believe that this concept is key as the future tool in order to stay in business [11].

These studies determine that the study field focus on the sustainability of the project, applying the sustainability perspective to the processes of the project management and delivery has been named as Sustainable Project Management [7].

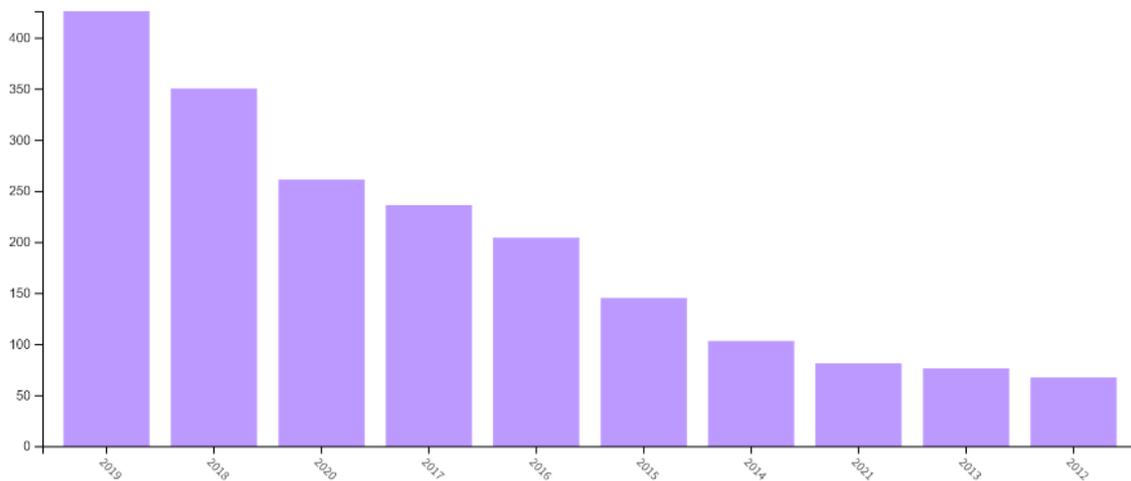


Fig. 1. Number of publications that contains Sustainability and Project Management in their title or abstract. (Source: Web of Science)

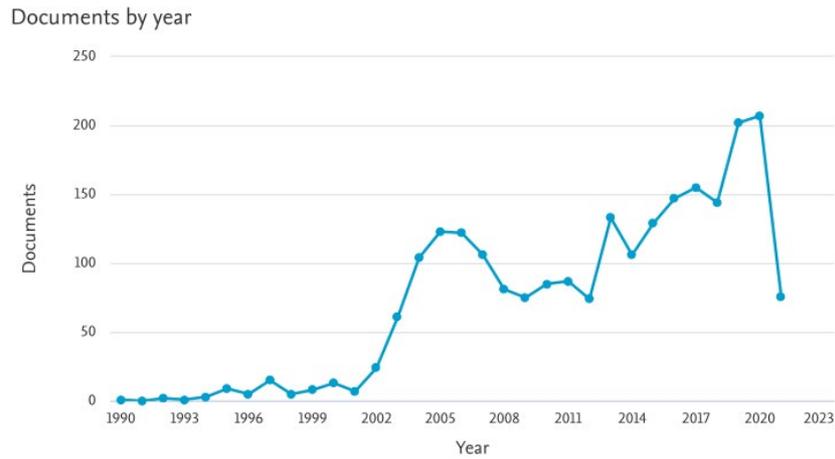


Fig. 2. Number of publications that contains Sustainability and Project Management in their title or abstract. (Source: Scopus)

In the previous figure it has been summarize the number of publications including sustainability and project management in their title and abstract. It started to established the first ideas along the 2012-2017 years, to increase exponentially after the 2018 year. For the search, it has been used the terms sustainability and “Project Management” as the specific term of Sustainable Project Management has been defined in 2020, and the previous studies used the terminology: sustainability in Project Management.

3. Responsible Project Management

The need for generating research field of Responsible Project Management started long time ag [12] expressing the important role of responsible management in a managerial occupation, but the real push for the field was caused by the development of the United Nations Principles for Responsible Management Education (PRME) initiative that in a few years flourished with a rapid emergence or research area and increasing number of publications, especially in all the major management learning and education journals [13],[14].

At the beginning, the research area was oriented to educational sphere, but during last years it has also switch to cover the responsible management itself [15],[16] also focused on the idea that it is urgent to implement the responsibility in the project management processes and included in the project manager’s jobs.

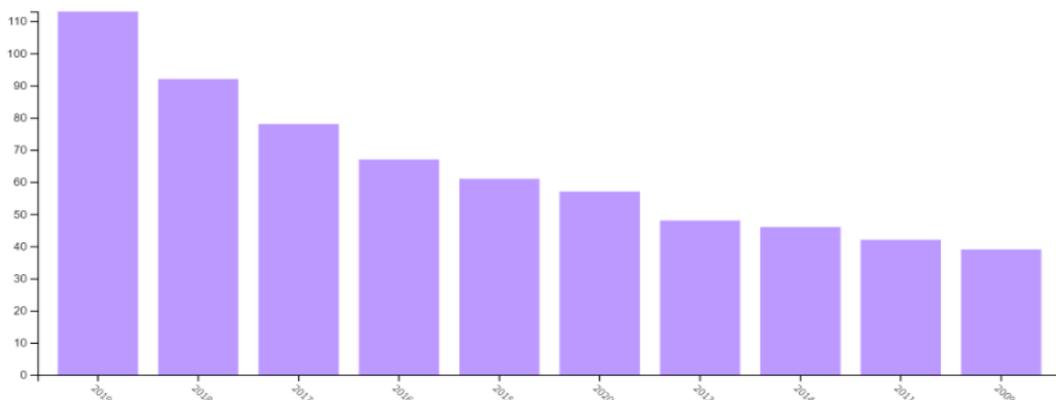


Fig. 3. Number of publications that contains Responsible and Project Management in their title or abstract. (Source: Web of Science)

Another of the research fields that have been identified as the input or “mother” of the current Responsible Project Management is the one that focus on Corporate Social Responsibility (CSR), but in contrast, this one is more oriented to the management in organizational level, while Responsible Project Management put the emphasis on individual-level, for building responsible managers and to implement responsible management processes.

Considering that this research field is just starting the trip alone, without the direct support of education field nor the Corporate Social Responsibility, it makes senses that the number of publications is quite smaller than the one for Sustainable Project Manager. It can be mapped with the first five years period, where there is a small number of publications but the number maintains constant and softly increasing.

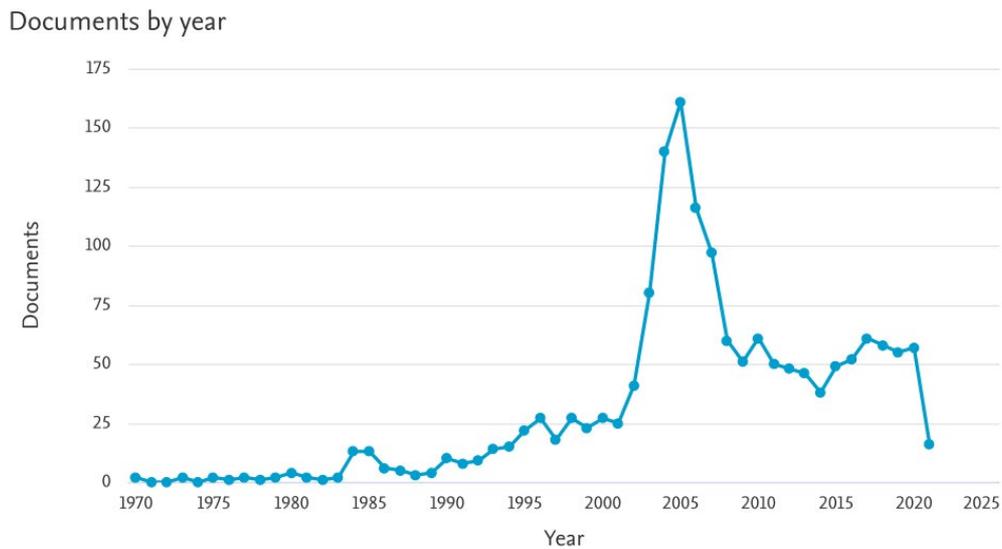


Fig. 4. Number of publications that contains Responsible and Project Management in their title or abstract (Source: Scopus)

Although, Responsible in Project Management is in a starting stage, as it has been based on Educational and Corporate Social Responsibility research fields, it makes sense to the peak of publications around year 2005. All this context has helped to produce basic fundamental driving principles to establish the base of the research field in an early stage. The manifesto build by the driving principles is the one that is going to be used in this study in order to map the main ideas with the Sustainable Project Management.

4. Dimensions' Comparison

In order to compare these two research fields, it has been used the information that has been published regarding the dimensions that define or characterize each of the fields.

In the Sustainable Project Management case, it has been overall accepted a 9-dimension collection [7] that has been collected based on many other studied that have built the base of the concept.

In the case of Responsible Project Management, there is a published manifesto, were there have been defined the 10 driving principles that are key drivers for facilitate project professionals to expand their roles by generating conscious awareness, circular approaches and increasing collaboration and engagement.

The dimensions and driving principles have been mapped to identify which are the shared concepts and to define which are the ideas that differ from each of the research fields. In the following figure, it has been established the result of the mapping process.

TABLE I. Mapping of Sustainable Project Management Dimensions and the Driving Principles of Responsible Project Management

Sustainable Project Management	Responsible Project Management
Balancing social, environmental and economic interests	Balance- Seek balance between the needs of people, planet and profit; short, medium and long term
Short-term and long-term orientation	
Considering local and global orientation	Purpose- Identify and understand the purposes underpinning projects from different perspectives
Considering values and ethics (in the project)	Stewardship- Encourage stewardship of human and environmental resources and ethical considerations
Having/Considering stakeholder orientation	Engagement- Engage with a wide range of stakeholders and promote common interests
	Transparency- Foster transparency and sharing of visions, thoughts, and feelings among stakeholders
Considering risks (management in the project)	Uncertainty- Recognise uncertainties and encourage clarity and sharing of new knowledge
	Anticipation- Anticipate changes, evaluate options and promote informed decision making
	Awareness- Raise awareness of possible impacts and consequences of projects
Including transparency and accountability (in the project)	
Eliminating waste (management in the project)	
Consuming income and not capital	
	Curiosity- Be curious, uncover and address ethical complexity, conflict, and unintended outcomes
	Creativity- Understand needs for creativity and innovations: make space for imagination

Source: The authors

The core ideas covered in the dimensions and in the driving principles are common and are oriented to the necessity of facing concepts as seeking the balance between needs of social, environmental and economic interests that need to be consider not only in short term orientation but also in long term consideration.

The idea of including local and global perspective is covered in both research fields as it is a key factor to identify the purposes underpinning projects including and considering different perspectives.

Another common concept is the fact of covering the values and ethics in the project by encouraging stewardship of human and environmental resources, without forgetting ethical reflections.

The stakeholder consideration is clearly included in the Sustainable Project Management dimensions and in the driving principles of Responsible Project Management, in both cases, there is a specific point that defines the importance of having and considering the stakeholder orientation, searching for a wide range of stakeholders and the promotion of common interests. Indeed, there is a specific principle that identifies the importance of sharing the vision and thoughts and feelings among stakeholders.

Finally, the dimension that focuses on the consideration of risk management in project, can be mapped with three driving principles: uncertainty, anticipation and awareness. All these principles are oriented to identify and anticipate uncertainties and changes, to evaluate options and encourage clarity and promote shared knowledge and informed decision making. Indeed, the idea is to be aware of the possible consequences and impacts of the project.

On contrast, there are some concepts that have not direct mapping between the research fields. In the case of Sustainable Project Management, the three dimensions are more oriented to accountability, income and capital and the point of eliminating waste in project management.

In the case of Responsible Project Management, the two driving principles that are not directly mapped are the ones that are closer to soft-skills: curiosity and creativity. These two principles are oriented to create appropriate spaces for the generation of creativity and innovation, using imagination by pushing the idea of being curious. Curiosity can be the path for emerging ideas to address the ethical complexity and conflicts and also for identifying intended outcomes.

5. Results and Conclusion

The Sustainable Project Management and the Responsible Project Management are contemporary research fields that try to update the Project Management including concepts as long-term orientation, as the time that the project was just important during the project execution has ended.

Nowadays, society and administration are requesting a broader approach that considers all the impacts before, during and after the project execution. Indeed, the stakeholder identification has completely evolved and has not just a local orientation, it has included a global orientation as the impact of a single project has not local boundaries as we are living in a global society.

The Triple Bottom Line established the bases for considering people, planet and profit, but other considerations need to complete this approach by giving the need importance to aspects as values and ethics, without forgetting about curiosity and creativity.

These two research fields will evolve in parallel, based on ideas that each of them wanted to push specially (Accountability and soft-skills) but considering and including their similarities to improve both approaches as a complete to build the base for the new Project Management era.

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ROLE OF BIM IN MITIGATING INFORMATION ASYMMETRY AND TRANSPARENCY: REALITY VERSUS EXPECTATION

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Abstract: *When we talk about digitalization and the construction industry, the first thing that comes to most people's minds is Building Information Modeling (BIM). In an industry that is often characterized by its low degree of innovation, BIM has been a noticeable exception to the general trend and has seen a surge in popularity during the last decade. In theory, one of the main advantages of using BIM is that it allows greater accessibility to information, which should help in reducing information asymmetry and the potential for any opportunistic behavior. However, there is a lack of research on the extent of this or whether digitalization actually creates new barriers for the users. This study attempts to identify the potential shortcomings of BIM-enabled information transparency in counteracting opportunistic practices. Using an anonymous questionnaire survey, we have mapped the perception of different representatives in the construction industry and compared their views. While there are no doubts about the benefits of BIM, not all users agree that it has been equally beneficial in all aspects. Results from the survey have revealed that some novice users may have a lower impression about the efficacy of BIM in reducing information asymmetry due to a lack of experience. Furthermore, the users' opinion is divided about the scale of information asymmetry and transparency that BIM prevents. The majority of respondents felt that BIM had the least effect when it comes to reducing extortion and unclassified acts (such as conflict of interest, professional negligence, etc.). Interestingly, these two are also ranked as the least likely to be improved by better information accessibility.*

Keywords: BIM, digital transformation, agency theory, information asymmetry, transparency, opportunistic behavior

1. Introduction

Despite the low level of innovation in the architecture, engineering, and construction (AEC) industry, the use of Building Information Modeling (BIM) has been increasingly dominant in the last decade. Although BIM started off as an alternative for paper-based drawings, it has been taking a much more holistic approach in recent years, covering things such as clash detection, quality control, etc. Evidence from the construction industry has shown that the use of BIM can result in cost savings and better control of the project throughout its lifecycle [1]. But there is a lack of research on whether or not BIM has given rise to new challenges for the users. Examples of such barriers can include information overload or lack of ability to pick up on information already available. Opportunistic practices can be triggered by a lack of transparency and the existence of information silos within the organization. If we look at the construction industry in light of agency theory, the relationship between an agent (contractor, vendor, etc.) and principal (the project owner, client) is often characterized by the distance between them. The agent often knows more and in-detailed information than the principal. This, in turn, gives them the flexibility to share information as they see fit. With the increasing use of digital communication technology in the workplace, this dynamic has shifted. The principal now has more control over the information and thereby can exert a greater degree of monitoring of the agents. In the construction industry, BIM has allowed owners to have far greater access to information than previously

possible. In theory, digitalization (such as BIM usage) is good when it comes to reducing opportunistic behavior because it can hold people responsible for their decisions. Prior studies have shown that increased information accessibility is expected to reduce the occurrence rate and severity of different opportunistic practices [2, 3]. However, there is a lack of research into the impact BIM has on information asymmetry and transparency in the construction industry and what we need to focus on moving forward.

This study is part of a larger research attempt, where we try to map how different representatives in the Norwegian construction industry feel about the impact of BIM. To do this, we use an anonymous questionnaire survey. The current paper reports initial findings from the survey. The research questions we are investigating here are:

- i. How do the respondents perceive BIM's influence on the different dimensions of information asymmetry and transparency?
- ii. How do the respondents foresee the potential for using better information accessibility in reducing room for opportunistic behavior?

In future research, combining the results from this study with the usage patterns of various BIM functions and insights from key personnel working with digitalization in the AEC industry will allow us to verify whether BIM has indeed been able to live up to its expectations in counteracting the room for opportunistic practices.

2. Theoretical Background

2.1 Agency Theory

Agency theory seeks to understand the problems that arise when one party (the agent) is acting on behalf of another (the principal) [4]. By definition, an agent is using the resources of a principal. The principal has entrusted money and/or other resources but has little or no day-to-day insight in how it is used. This makes the agent the decision-maker but incurs little or no risk because any losses will be borne by the principal. Agency theory assumes that the interests of a principal and an agent are not always aligned. This is sometimes referred to as the principal-agent problem. Agency theory dictates that if there exists goal incompatibility between the principle and the agent, the agent will try to take advantage of his position for personal gains. The agent can get away with this because he has more in-depth knowledge about the subject and the principal lacks both time and resources needed to follow up on them. If the agent wants to maximize the utility from their relationship, they will not always act in the principal's best interest.

This is due to the following issues:

- The agent will try to maximize their own interest at the cost of the principal.
- Goal conflict means that when faced with a decision, the agent will try to prioritize his objectives over that of the principal's.
- Agents are risk-averse, while principals are risk-neutral. As a result, the agent may end up doing things contrary to the principal's interest for protecting himself.

The main challenge in agency theory is to reduce this agency cost to an acceptable level. To address this information asymmetry, agency theory suggests that the principal will try to install closer monitoring and greater accessibility to all relevant data [5]. In the construction industry's context, BIM helps the project owner get better access to relevant data, which in theory should help reduce the magnitude of principal-agent problems.

2.2 Information Asymmetry and Its Potential Consequences

Information asymmetry occurs in a project when one of the parties involved tries to take advantage of the other by being more knowledgeable about some details regarding the exchange of payment and services [6]. Multiple principles and multiple agents make this relationship more complex and sometimes increase informational asymmetries and difficulties in monitoring. Information asymmetry allows agents to opportunistically take advantage of the client due to an imbalance in the information. The three dimensions in which information asymmetry can affect a project are as follows:

1. **Adverse selection:** This refers to the situation where the principal is unable to select a qualified contractor due to a lack of knowledge or expertise [7]. For example, in large or complex construction projects, the work is often awarded to a single contractor who transforms the principal's idea into a tangible design based on their expertise. The principal in this scenario depends on the contractor to provide him with the correct information with no alternate means of verification available at his end [8]. Adverse selection usually takes place before awarding the contract.
2. **Moral hazard:** Even though both parties enter into a contract based on mutually agreed upon terms, the agent may try to opportunistically take advantage due to the principal's inability to fully supervise the agents [9]. This can result in high cost and time overruns because the cost for the principal is much higher than the gain for the agent. Moral hazard typically takes place after the contract has been awarded.
3. **Hold up:** This is a scenario where the contractor withholds information from the client. This can result in the client awarding the contract to someone who can then manipulate any incomplete information or ambiguity in description to increase the profit margin by claiming variations, fraudulent claims, etc. [10].

2.3 Transparency

Transparency is an important concept associated with agency theory as well as with the accessibility to information. Many define transparency as the degree to which the relevant information is visible to them. While this is true, it only covers a limited scope of the concept. This definition has evolved over time. Transparency can be conceptualized as the degree of information disclosure, clarity, and accuracy [11]. These three dimensions can be briefly explained as follows:

1. **Disclosure** is defined as the perception that the relevant information is received in a timely manner [12]. It does not mean to openly share all the relevant information but only those that are relevant for the receiver at the time. Otherwise, an overload of irrelevant information can often make things more difficult for the decision-makers.
2. **Clarity** is about ensuring that information is made available at an appropriate level so that the receiver does not have to struggle with deciphering its meaning [11]. However, this can be challenging because the ability to interpret information depends on the receiver's capability, and a common level of details is hard to agree upon. A few scrupulous agents may want to take advantage of this by sharing highly technical analysis with a stakeholder who then does not have the capability to make sense of it.
3. **Accuracy** differs from disclosure and clarity because it is about the information's reliability rather than completeness or understandability [13]. It is about the correctness and validity of the shared information.

2.4 Opportunistic Behavior

Opportunistic practices in the construction industry can be characterized by the party that initiates them- either contractor-related or project official-related. Such practices can range from anything like negligence of work to something as sinister as nepotism, using front companies, etc. Based on the literature review, the different kinds of opportunistic practices are listed in Table 1.

TABLE I. Opportunistic Practices in the Construction Industry

Type of behavior	Role of the agent (contractor)
Bribery	Such acts can include bribing the relevant officials to get work approved, giving kickbacks, lobbying to influence any decision, etc. [14].
Fraudulent acts	Fraudulent acts include any act of deception done with the intention of cheating. This can include using front companies that have no real existence, lying about competencies, submitting inflated variation claims, intentionally covering up poor workmanship or defects, etc. [15].
Collusive act	This includes forming cartels, where two or more competing firms band together to create a monopoly over the supply of materials or services. This also involves price-fixing, where the colluding firms agree to submit bid prices that are above the general market rate [16].
Extortion	Extortion means the unlawful use of one's power or knowledge for intimidating others in the form of blackmail, threats, etc. [17].
Discriminatory acts	This includes favoritism and nepotism, such as giving special preference to a person/group based on their background, personal relationship, etc. It can range from something seemingly trivial such as providing early information about an upcoming project, to something as severe as awarding a contract to a firm without suitable qualification [14].
Unclassified acts	This includes acts like a conflict of interest (where an individual has to decide between professional demand and personal interest), professional negligence, etc. [18].

3. Research Methodology

This research aims to map how the representatives of the construction industry feel about the impact of BIM in improving transparency and information accessibility. First, we did a literature review on the relevant topics to identify the different aspects of information asymmetry and transparency. We also created a list of the most commonly occurring forms of opportunistic behavior in the construction industry. Next, the questionnaire was designed keeping in mind how the different data points will be modeled, quantified, and visualized at a later stage. Based on the results from the survey, we analyze the key trends and discuss what the root cause may be. We also present some of the shortcomings of our approach and conclude with a remark on the future research directions.

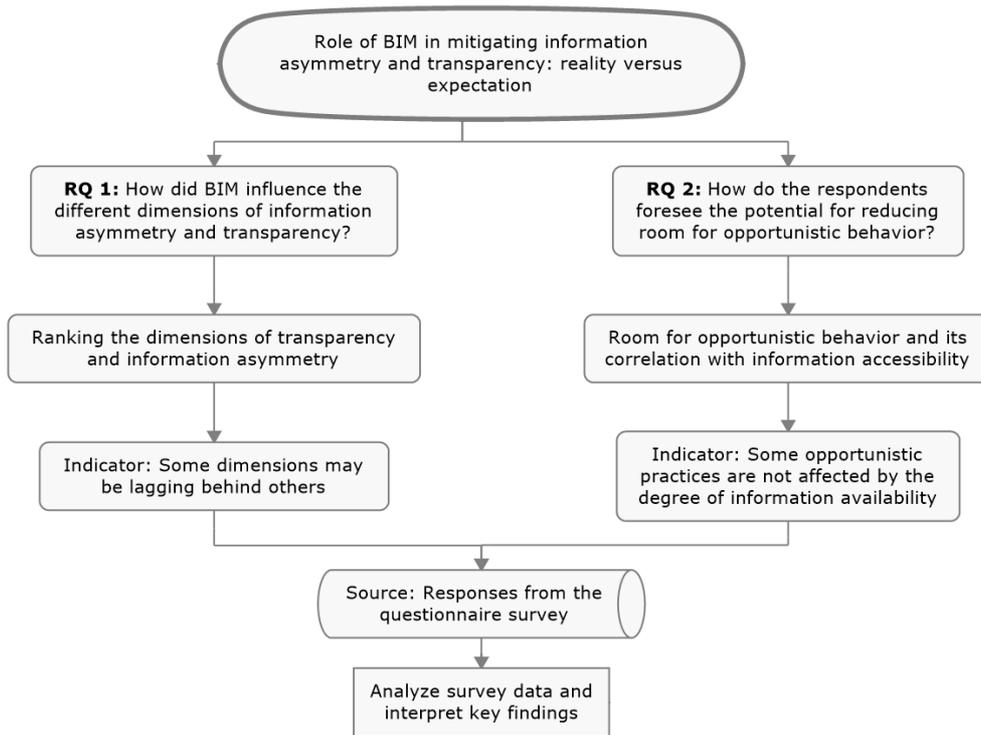


Fig. 1. Research methodology

3.1 Survey Design

The preliminary survey design had 12 questions that took about 15 minutes to complete. Because of the relatively long duration, the completion rate was low during the pilot phase. After several iterations, the survey was reduced to 10 minutes by making the last section optional. 14 out of the 32 respondents (43.75%) went on to complete the optional section. Due to the topic's sensitive nature, we opted to go for an anonymous questionnaire survey that allowed participants to share their opinion without any hesitations. Also, the survey form did not collect any personally identifiable data in full compliance with General Data Protection Regulation (GDPR).

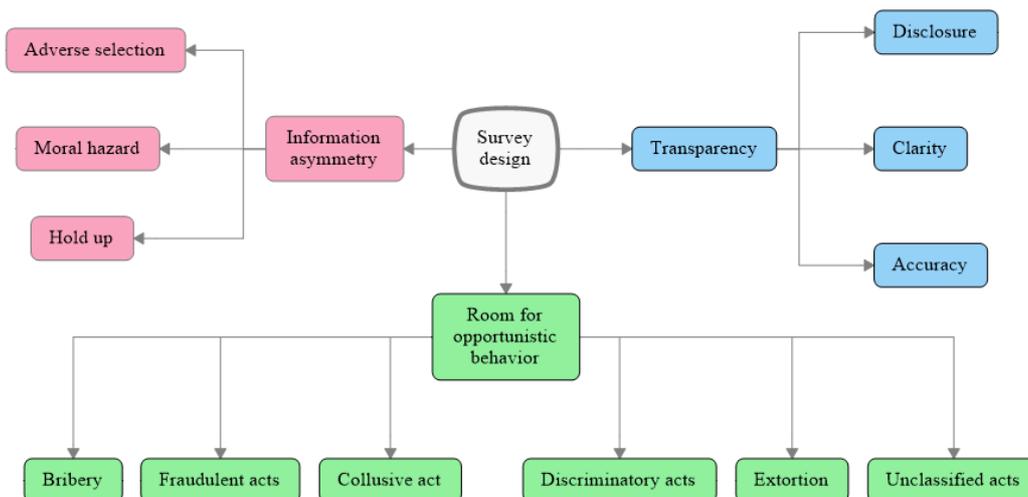


Fig. 2. Survey design

The first section of the survey was for collecting basic demographic information. The main body of the survey consists of 3 sections in total, as shown in Fig. 2. For both the information asymmetry and transparency sections, the respondents were asked to score the different dimensions under each of them (as explained in the theoretical background section). Then, for the optional part, the respondents were asked to rank the impact of BIM on room for opportunistic behavior and the potential for improving it further with better access to information.

3.2 Response Collection

The survey form was distributed through the mailing list of Prosjekt Norge and published on their website. Prosjekt Norge is an association for project management professionals working in different industries in Norway. This was an appropriate channel to reach a broad range of audiences, many of whom are actively working in the AEC industry. We got a total of 32 responses from the first round of survey distribution. While this is not enough to establish statistically valid data, it functions as a proof of concept and gives insight into the respondents' views on the matters at hand.

3.3 Data Analysis and Visualization

For the "information asymmetry" and "transparency" sections, the dimensions were ranked on a four-point Likert scale between no effect and major effect. Here, we have opted to use a Likert scale because it measures the respondent's attitude into quantitative measures, which can then be used for analysis purposes [19]. To quantify the results, scores shown in Table 2 were assigned to each response, and the final score was calculated.

TABLE II. Conversion Table for Responses

Response	Score
No effect	1
Minor effect	2
Moderate effect	3
Major effect	4
Strongly disagree	-2
Disagree	-1
Neither agree or disagree	0
Agree	1
Strongly agree	2

TABLE III. Calculation of Information Asymmetry Dimensions

Dimension	Count of responses				Score	Average
	No effect	Minor effect	Moderate effect	Major effect		
Adverse selection	2	5	11	14	101	3.16
Hold up	4	12	14	2	78	2.44
Moral hazard	3	11	9	9	88	2.75

A sample calculation for quantifying the responses is shown in Table 3. When we asked the respondents how BIM has affected the adverse selection dimension, 2 replied "no effect", 5 replied "minor effect", 11 replied "moderate effect", and 14 replied "major effect". Then the final score was calculated using the conversion table (Table 2) as $\text{Score} = (2*1) + (5*2) + (11*3) + (14*4) = 101$. Similarly, we find out the total scores for the "room for opportunistic behavior" section as well, which uses a five-point Likert scale.

4. Results and Discussion

As illustrated in Fig. 3, the majority of respondents (93.75%) had some prior knowledge about BIM usage, which indicates that the responses are not arbitrary, rather a product of experience with using BIM. Furthermore, the bulk of respondents (71.88%) have worked in the construction industry for more than ten years, and 78.13% have had the experience of managing more than 15 projects. This is a good indicator of the quality of responses we have got so far. The respondents are almost evenly distributed in terms of affiliation, signifying that no single group dominates the results.

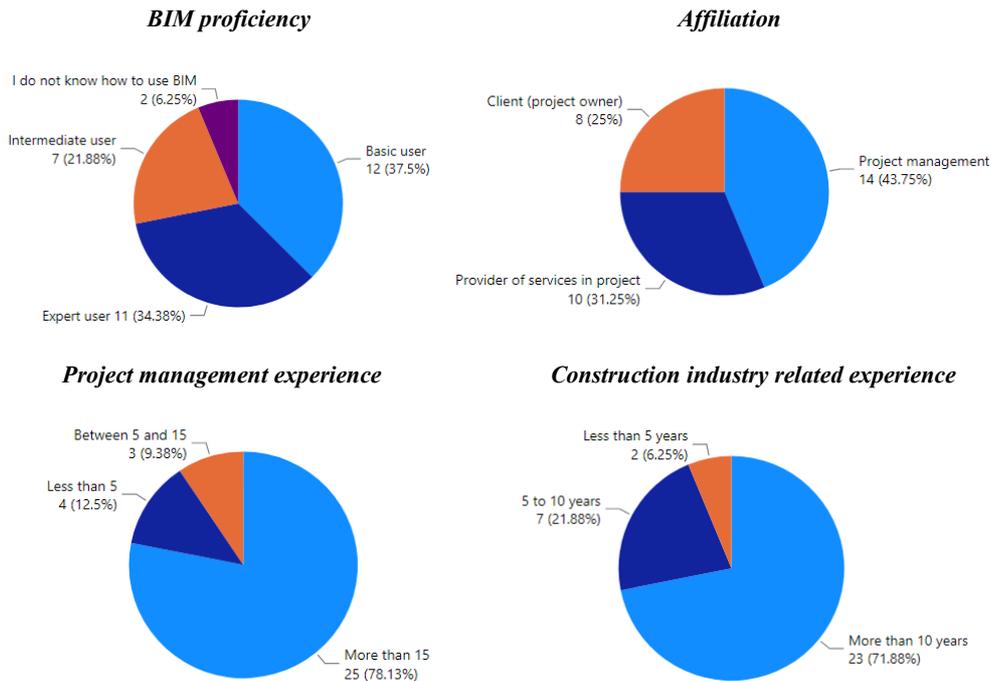


Fig. 3. Respondent's profile

4.1 Information Asymmetry

The average value for information asymmetry is 2.78 on a scale of 1 to 4, which gives an overall satisfaction rate of 69.5%. This conveys those respondents are in general happy with the overall effect BIM had on transparency. If we look at the distribution of responses in Fig. 4, it shows that more people are convinced about the effect of BIM on adverse selection (44% chose BIM as having a major effect) than the other two dimensions. Prior studies [1, 2] noted the importance of BIM in reducing adverse selection (by promoting better decision-making), which is further reinforced by this result. From the respondent's perspective, the largest room for improvement is in the moral hazard dimension (51% of respondents saying BIM either had no or minor effect on it). One possible explanation is that while adverse selection and hold up are reduced since the agent has to submit information, moral hazard is closely related to the agent's mentality or attitude, which cannot be captured in BIM.

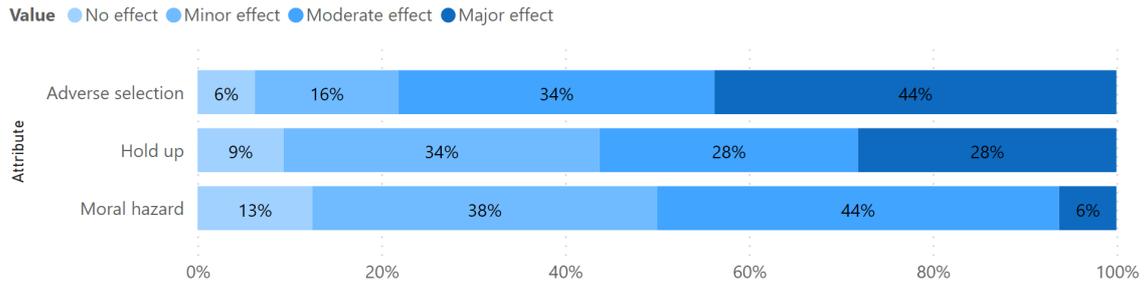


Fig. 4. Effect of BIM on dimensions of information asymmetry

4.2 Transparency

Overall, the average value for transparency is 2.96 (on a scale of 1 to 4), giving a satisfaction rate of 74%, which indicates that the respondents have a more positive outlook on this compared to information asymmetry. Interestingly, BIM had the most substantial impact on improving disclosure (6% above category average), with 87% of respondents reporting that it either had a moderate or major effect, as shown in Fig. 5. This result is expected because one of the main selling points for BIM is that it allows users to access information on time. On the other hand, the clarity and accuracy dimensions have scores that are close to the category average, which indicates that BIM has had a balanced effect on mitigating these anomalies.

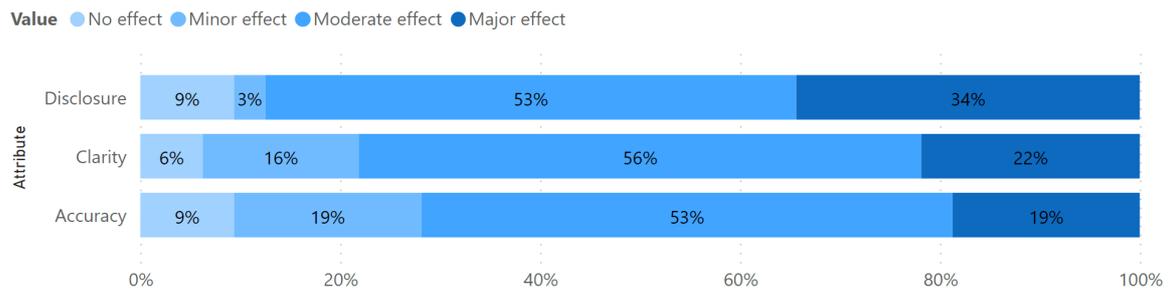


Fig. 5. Effect of BIM on dimensions of transparency

4.3 Respondent's Background and Its Impact on the Results

TABLE IV. Information Asymmetry Classified by Respondent's BIM Experience

BIM experience level	Score	Deviation from average
I do not know how to use BIM	2.0	-28.1%
Basic user	2.53	-9.1%
Intermediate user	3.43	+23.3%
Expert user	2.79	+0.2%

TABLE V. Transparency Scores by Respondent's Affiliation

Respondent's affiliation	Score	Deviation from average
Project management	3.29	+11.1%
Client (project owner)	2.67	-9.9%
Providers of service in project	2.73	-7.6%

Although there are many interpretations possible from the data at hand, only the most significant findings are presented here. The scores for information asymmetry are given according to the

BIM proficiency level of the respondents in Table 4. The basic users of BIM are a bit skeptical for information asymmetry, scoring it 9.1% below average, while intermediate users have the most optimistic outlook, scoring it as 23.3% above average. Interestingly, expert users have an average value of 2.79, which is very close to the section average of 2.78. One possible explanation for this result is that, as users become more familiar with BIM, they have a higher opinion of the system. In other words, those who have a negative impression may have that because they are not well familiar with its potential. This hypothesis is further reinforced by the fact that the users who do not know how to use BIM have given it an average score of 2.0, which 28.1% below the category average.

On the other hand, for transparency, if we analyze the responses based on affiliation as shown in Table 5, only the respondents from project management background ranked it higher than the average (2.96) while both clients and providers of service (e.g., contractors, suppliers, etc.) have rated it below the average value. There are several possible explanations for this result. Perhaps the providers of service have ranked it lower because, as shown in a previous study, they have more at stake if the transparency is compromised [20] and hence, have a more cautious attitude.

For the clients, it may have to do with their lack of expertise with BIM (62.5% of respondents from the client-side identified as basic users of BIM). As we have already indicated, this negative impression can be due to their lack of understanding and not an actual issue with BIM. If that is true, it can be assumed that if the clients had higher BIM expertise/knowledge, they would have a much more positive attitude about the impact of BIM in improving transparency. Another way to interpret this result is, we need to focus on improving the BIM proficiency level of the clients to at least an intermediate level for them to fully realize the potential of BIM.

4.4 Information Accessibility and Room for Opportunistic Behavior

Before we go further into opportunistic behavior, it should be specified that we are talking about the possibility of such practices occurring due to BIM's limitations. Just because there is room for opportunistic behavior, it does not mean that the users will participate in such practices. Overall, as shown in Fig. 6, there is a modest tendency to see a positive effect from BIM on opportunistic behavior. Interestingly, the respondents felt that BIM was least effective when it comes to reducing extortion and unclassified acts (93% of the respondents felt that BIM had no or minor effect). One possible explanation for this is that extortion (intimidation, threat, blackmail, etc.) and unclassified acts (such as conflict of interest, professional negligence, etc.) mostly take place through channels that are not documented in BIM [14]. As such, hardly any traces of them are found in BIM, which hinders its ability to counter these practices.

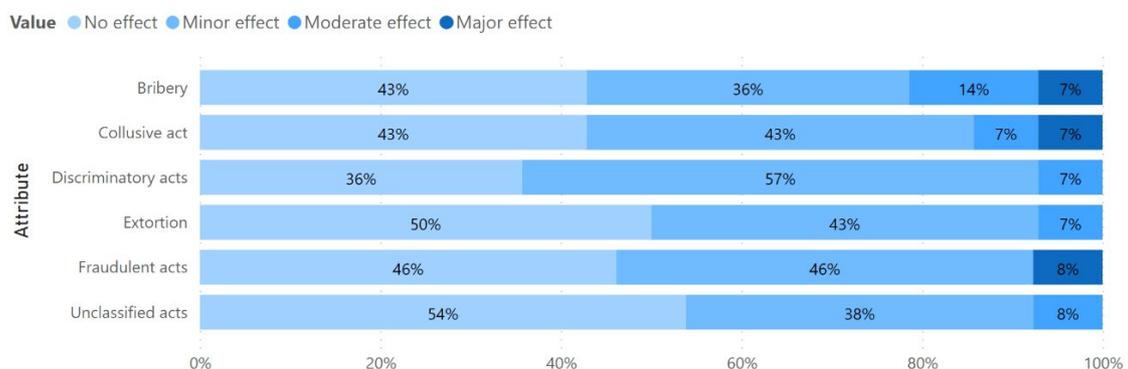


Fig. 6. Perceived impact of BIM on the occurrence rate of opportunistic behavior

When the respondents were asked whether better access to information will help reduce the possibility of such practices, it is interesting to note that none of the respondents chose either extreme of the answers (strongly agree or disagree), as shown in Fig. 7. This may indicate that they may not have experienced this issue and therefore have no clear stance. Out of the 14 respondents that filled in this section, only one person had a negative impression and disagreed that better accessibility will help on 5 out of 6 occasions. In general, a critical insight from this section is that extortion and unclassified acts are considered the least likely to be improved with better information accessibility. One possible explanation for this result might be that the two practices in question rarely occur in the Norwegian construction industry, and the respondents do not have enough context to develop a strong opinion on this. Furthermore, in rare instances when extortion and unclassified acts occur, it is often done through channels that are not registered in BIM. Hence, further improving information accessibility will not impact them.

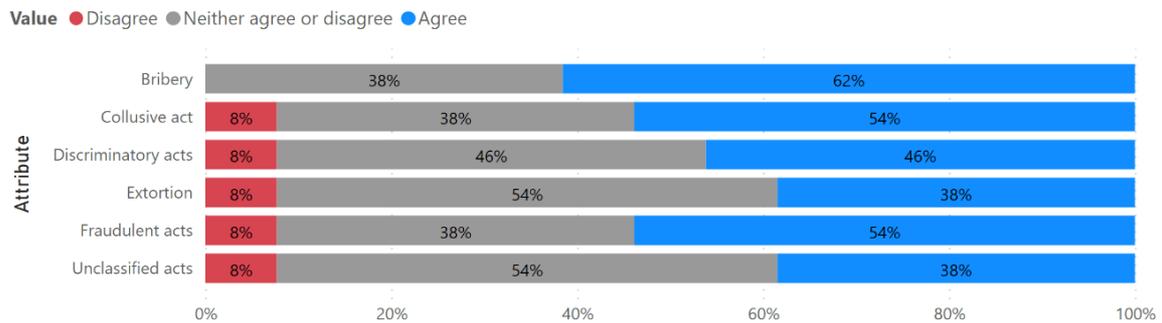


Fig. 7. Possible impact of better access to information in reducing opportunistic behavior

5. Conclusion

The research questions that we set out to investigate are- (1) how the respondents perceive BIM's influence on the different dimensions of information asymmetry and transparency and (2) how they foresee the potential for using better information accessibility in reducing room for opportunistic behavior. Overall, BIM has been performing well in removing information asymmetry and transparency, with adverse selection and disclosure as the clear winners. However, the current practices have had little effect when it comes to improving the moral hazard dimension. Interestingly, the respondent's proficiency in BIM shares a strong correlation with his perception of BIM's capabilities. When it comes to opportunistic practices, not every type of behavior has to do with the lack of data. Certain practices like extortion and unclassified acts have not seen any significant improvement from BIM implementation, and it is unlikely that better access to information will improve the situation.

The results presented here are based on 32 valid responses that were received in the first round of survey distribution. However, with such a small sample, caution must be applied, as the findings might not be representative of the industry as a whole. To overcome this, we have already planned for more rounds of survey distribution, and it will be combined with interviews with key personnel to find out their interpretations. Another limitation of this study is that the Norwegian construction industry uses a more advanced iteration of BIM compared to most parts of the world [21]. As such, a similar study may not be able to replicate the same results if it takes place in a region with a different BIM standard.

This study has brought up more new questions than what it has answered, and the early signs indicate that there are plenty of reasons to be excited about future research potential. More importantly, this study has given us a strong indication of the questions we should be probing. For instance, since BIM does not have much influence on the moral hazard dimension within

information asymmetry, further research is needed to identify how this can be improved. Also, how can we reduce the risk of opportunistic practices like extortion and unclassified acts, which are not likely to be influenced by better information accessibility? This is significant because asking the right question will go a long way in discovering trends and ensuring that future developments in BIM will have a targeted effect in mitigating those anomalies.

6. Data Availability

The data used in this paper is available as an interactive dashboard on the following website: www.tausifahmed.com/opportunisticbehavior. If you are having trouble viewing the report, please contact the corresponding author.

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THE NECESSITY TO USE BLOCKCHAIN IN IOT/ IIOT

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Abstract: *Overgrowing demand of Internet of Things (IoT), billions of smart devices are deployed worldwide to make them intelligent itself and provide numerous facilities to human. IoT is promising technology for development of different home automation systems and for industrial applications. Acquiring several benefits of automation from IIoT services in industries, is giving escalation to IIoT. Due to large amount of data sent by millions of smart devices, many challenges are faced by IoT/IIoT in terms of data accessibility, interoperability, data integrity, data security and privacy. In this research, we explored several cyberattacks in IoT devices due to lack of data security, other challenges with current centralized IoT/IIoT architectural model and how blockchain is proved as effective technology to overcome IoT/IIoT challenges. Blockchain is distributed ledger to create temper-proof transactions and share them among all blocks by maintaining traceability, integrity, security, and transparency.*

Keywords: blockchain, smart contracts, ledger, Internet of Things (IoT), industrial Internet of Things (IIoT), security

1. Introduction

With large expansion of technologies, the Internet of Things (IoT) is becoming in demand for many businesses and firms to reduce human labor. IoT makes “Thing” enable to connect and communicate, therefore, transforming from real world into huge information system via “Internet” [1]. IoT connects smart devices that have processors, communication hardware, and sensors, to the internet, sends data to the cloud through IoT gateway, and performs required action. The utilization of IoT solutions, in last decade has spread up in many different sectors and industries including healthcare, finance, government, transportation and among others where industrial IoT (IIoT) is used to merge new technologies such as machine-to-machine (M2M), smart sensors, artificial intelligence, big data analysis and much more into conventional industrial procedures to make them efficient for consumers. [2].

The main goal of IIoT is to manufacture intelligent products with initiating good connection between customer and business partners and along with its emergence, Industry 4.0 is emphasizing on digitalizing all physical processes across the entire organization where machines are furnished to visualize overall manufacturing flow and make intelligent decisions by wireless connectivity, sensors and connected with Cyber Physical Systems (CPS) [3]. IoT has created its norm globally, millions of simple and sometimes tiny devices are connected to the internet and provide services, besides that, current access control systems which is centralized, and hierarchical structures produce new challenges in IoT domain. IIoT is utilizing centralized cloud to communicate with devices so there is single failure node, can be hacked or disrupted, and may lead to many other problems [4].

As users of smart devices are very much concerned with security and privacy of their data, undeniably they cannot develop as IoT is not meeting required privacy and security standards and procedures. In fact, according to Gartner’s research that is conducted globally, expenditure for security of IoT will extend \$1.5 billion in 2018, lack in “security by design” specifically comes

from firm's regulations, and from 2021, IoT security will be complied as prime factor in smart devices [5].

Blockchain is providing transparent, trustworthy, efficient, and suitable solutions to the challenges that are faced by IoT/IIoT. Blockchain is decentralized, immutable, shared decentralized database ledger that contains chained blocks of data to store transactions safely [6]. As violation of privacy and security in systems may lead to unrepairable harm and companies/businesses growth can be affected badly that is why many businesses are going towards blockchain technology [7].

2. Motivation: Why Blockchain?

Blockchain is technology with the capability to transfer/save/add data in a digitally decentralized, peer-to-peer, inviolable, and distributed manner that is very much valuable for IoT devices to make them more powerful, fast and secure [8]. In IoT, data is coming from enormous devices that is such a big challenge to manage in secure way otherwise it will affect decision making badly which can be very dangerous for many sectors especially healthcare, transportation and so on [1]. IoT networks are very much costly to manage large amount of data in centralized approach, it has single point of failure as cloud model because of single node data can be used illegally and can damage consumer in different ways [9].

Examine IoT device that is smart water meter and related threats. Around twenty percent in California, people have installed smart water meter to get information of water seepage and usage on their phones. So, water usage data can also tell criminal when consumer is at home or not and this is very crucial information, there is high chance of larceny. Centralized cloud model is enabled to update data without ensuring that is it good, correct, and legal data to manipulate. Besides, in blockchain information travelling between smart devices is such as money transactions. To send data, devices do trust on smart contracts which are digital agreements that are programmed to fulfill predefined conditions. Blockchain uses Cryptography to confirm the originator of data, so, data will be sent in secure way without being targeted in-between of transaction [9].

3. Properties and Strengths of Blockchain

Blockchain is distributed, immutable database system with block-based data structure where blocks are chained together with including hash of previous block and follow consensus algorithms for allowing data to be transferred among multiple entities. Major difference between blockchain and the other technologies is that, it is the only one that have these three properties simultaneously [1, 10]:

1. *Trustless*: It means the entities of blockchain can exchange data without need-to-know digital identities of each other. Amount of trust needed for individual entity is minimized.
2. *Permissionless*: There are neither permissions nor controllers for anyone to join network, for taking part in block verification process using consensus and for creating smart contracts on the blockchain network.
3. *Censorship Resistant*: Blockchain entities rely on cryptographic algorithms that rule the process so that anyone can perform transaction and once it is performed no one can alter, stop or delete it.

After making this important distinction, it is crucial to figure out what problems BC can help with. Take example of person that is bob and he wants to perform transaction, so, traditionally a centralized Trusted Third Party (TTP) approach will be used with the steps to identify id of user, connect with bank account, and perform transaction; but with blockchain, you don't need to use

TTP, and you can fast your transaction with decentralized approach and make it cheap. In fact, bitcoin transaction fees are entirely optional [1].

Blockchain technology has following main concepts which are making it robust and distributed:

1. *A peer-to-peer network*: This approach eliminates the need for a central TTP, meaning that all nodes in the network have the same rights and enhance the security and scalability. Nodes in this network can communicate with one another using a pair of private/public keys. The private key is used to perform transactions, while the public key act as an address to be traced on the network [1].
2. *Transparent and distributed ledger*: Consider a ledger as an accounting book that records all the network's transactions in chronological order and maintained by distributed consensus algorithms. This ledger data structure is not a centralized entity; instead, each node has a copy of it. Everyone can see the ledger because it is transparent and public. The ledgers are storing everything of value, value can be financial transaction but in IIoT it would be data, token, or any event send by devices [1, 10].
3. *Ledger copies synchronization*: A way to synchronize ledgers across nodes is needed in this case, where each node has its own copy of the same ledger. To achieve this goal, three key steps must be taken: (a) the new transactions must be publicly broadcast to the network; (b) to verify new transactions, and (c) to populate the ledgers with the validated transactions [1].
4. *Mining*: There are network delays in a distributed system, and not all nodes receive transactions (multiple transactions, to be minimized) at the same time. Since the chain must only have a legitimate and ordered branch, it is necessary to prevent any node from adding a transaction to it. Miners are special nodes that can understand which transaction should be added, validated and put in chain first [1].
5. *Chaining blocks*: The most recent transactions that are not added into any block can be verified by participants in blockchain. A block is like a page in ledger that combines all performed transactions in overall system, then those transactions will be mined by miners before adding in blockchain. Each block contains header, which adds the hash header of preceding block, this way all blocks would be chained in blockchain [2].
6. *Consensus models in blockchain*: Many mining blocks want to generate new blocks around same time; this consensus methodology is used to add new block in blockchain. Methods used this process are Proof of Work (PoW), Proof of Stake (PoS), Round Robin and so on [2].
7. *Smart contracts*: A smart contract is agreement (with terms and conditions) that is programmed and followed by all nodes in blockchain. It is legal contract in digital format with set of protocols. It implements safety, trust, autonomy, accuracy and efficiency on data that is exchanging across blockchain network and also saves money by removing the need of centralized TTP [1, 2].

4. Architecture: IIoT and Blockchain-Enabled IIoT

The IIoT platforms, which can deliver smart connected operations through devices, link properties, and allow following capabilities: networking, analysis of large amount of data, and application creation [2].

Fig. 1 shows current architecture of IIoT platform, the sensing layer refers to deploy facilities, while the network layer provides communication for IIoT modules, the service layer provides cloud and big data analytics services, and the application interface layer provides application advancement. In this architecture IIoT is facing reliability, interoperability, and data security issues due to centralized cloud model and lack of security measures. On the other hand, IIoT systems using blockchain can connect untrusted devices in a distributed and verifiable way.

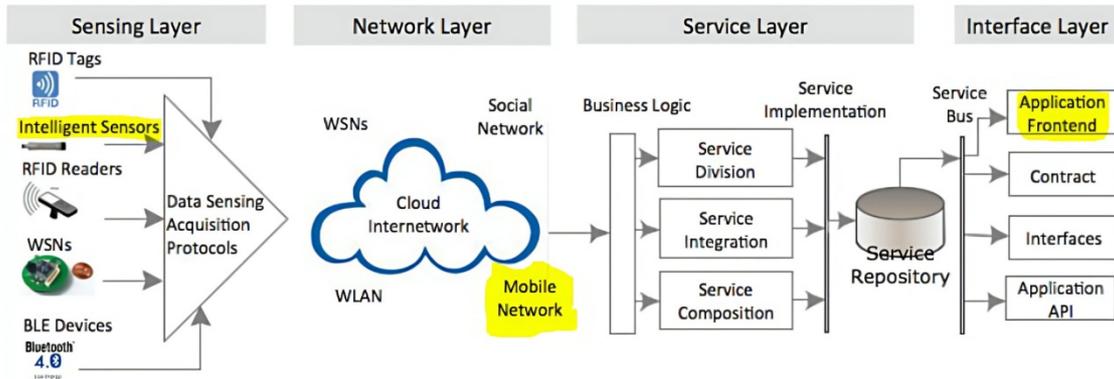


Fig. 1. Architecture of an IIoT platform [2]

Fig. 2 shows an example of the architecture of a blockchain-enabled IIoT system, which contains the following six main components [2, 4]:

1. *IIoT Resource Networks/Sensor Networks:* In this network IIoT assets/devices are included for establishing encrypted connection to communicate and ensures unique identifiers for devices.
2. *Blockchain Network:* It creates a decentralized private network that stores all information in the systems as temper-proof. In this network miners help to make connection secure and stable by taking decision to approve transactions from bunch of transactions.
3. *Management Hubs:* This component is primarily responsible for the overall system's management and maintenance. It provides the interface to translate encoded information sent by smart devices into messages readable by nodes of blockchain.
4. *Key Servers:* These servers produce the cryptographic keys that are needed for node authentication and data encryption.
5. *Clients:* Users who seek access to IIoT services are referred to as clients.
6. *Smart Contract:* It establishes system interfaces between IIoT components and blockchain. All policies and conditions for all operations are defined in it and its globally accessible.

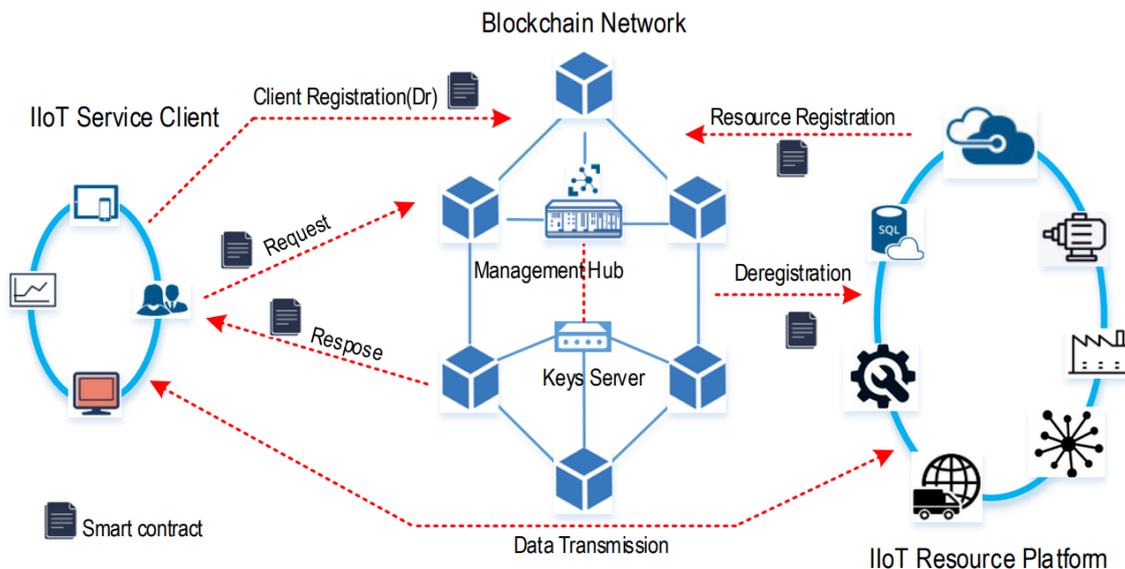


Fig. 2. Blockchain-enabled IIoT architecture [2]

5. Features of Blockchain as Solutions to IIoT Challenges

As IIoT is growing very fast, so risks are also increasing and are affecting in many ways, device's authentication is very much crucial as compare to other verification [2]. Main features of blockchain which are currently big challenges faced by IIoT, are summarized as follows:

1. *Lack of cooperation among IoT platform:* Lack of interoperability is major challenge faced in IIoT platforms as large amount of data is created from interconnected devices which needs higher level of communication way in-between. IIoT works in silos that automatically escalate problems and cost. Blockchain guarantees to provide strong links between devices and immutable data sharing. Also, smart contracts check consistency in authenticate manner [11].

2. *IoT Data security Lack and Accountability:* Heterogeneous devices are used with interconnected networks in IIoT and using centralized cloud model, can lead to many security problems and malware attacks. Accountability is basically to ensure trust in IoT devices and services about their functionalities and behavior. In blockchain, smart contracts are used with set of predefined rules and regulations in overall process to authenticate data. With a digital pseudonyms (a hash of an address) one can trace activities of an entity by unique identity, this feature can make tamper-proof log for accountable IIoT [2, 11].

3. *Significant Transparency:* Blockchain can exchange information, perform transactions in quite transparent way as all participants in decentralized ledger share same documentation and cannot be altered. A slight change in any record, will be updated throughout the network that is why in blockchain, data is consistent, accurate, transparent, and accessible for each participant [2, 11].

4. *Upgraded Traceability:* Due to complexity in network, IIoT is facing a lot of difficulty in tracing accurate information and links without any authentic proof. Blockchain enables verifications and transactions can easily auditable. Blockchain can track sources in supply chain and deal with situations when safety and privacy issues are found. Blockchain implements traceability when data security is ensured by smart contracts and data immutability [2, 12].

6. Applications of Blockchain for IIoT/IoT

Manufacturing Industry: In this industry, technical manuals are published for products by producers and other departments like repair and maintenance must access it. These manuals should be released and updated on time, that is very long procedure including lots of paperwork. Blockchain technology can easily manage it and can provide access of latest document to every user of blockchain without getting panic of updated version. Uploading data on distributed ledger has increased efficiency of work in manufacturing industries. Such as, in automobile industry, accessibility of spare parts is unknown in actual which is necessary information. By using blockchain technology, required information for spare parts can be updated on shared ledger that can be accessed by every involved entity, for example, distributors of warehouse, manufacturer of car, etcetera. In manufacturing sector, incorporation of IIoT, is reducing a lot of effort and time but lacking in security and privacy concerns. Blockchain is also securing data interaction in smart industry system by using private blockchain architecture consists of an extranet for data usage and an intranet for gathering and saving data. Device's data is still saved on cloud, just interconnection data shifts on blocks, therefore it will be secure and lightweight solution [13].

Blockchain used in authentication scheme for IoT devices: IoT devices are facing many security challenges like handling many new terminals is difficult by current management system of network, there are no guaranteed security standards for IoT devices. Based on blockchain infrastructure an out-of-band two factor authentication scheme is designed for IoT devices to overcome security issues. This scheme enhances the process of authorization and authentication and conduct secondary authentication to differentiate malicious devices around the home IoT device by using smart contracts [14].

7. Conclusion

To make IIoT platform more efficient, secure, and trustworthy so that businesses can establish seamless connection with consumers, blockchain technology provides great solutions to challenges that need to be addressed. Blockchain technology is giving data integrity, authenticity of data and make it secure by using smart contracts. This research shows how blockchain is beneficial for IIoT and analyzes that how challenges can be overcome. Further, integration of blockchain in IoT/ IIoT has ensured to be reliable and valuable as compared to conventional centralized system.

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DEVELOPMENT OF MACHINE LEARNING MATURITY SCALE (MLMS) FRAMEWORK IN THE CONTEXT OF INDUSTRY 4.0

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Abstract: *The new industrial revolution Industry 4.0 (I4.0) is an encompassing concept of emerging and developing technological trends such as Machine Learning (ML), Internet of Things (IoT), Big Data Analytics, and Cloud Computing. ML is one of the paramount concepts of I4.0 which aims to provide systematic analytical data modeling and forecasting of results. Application and implementation of I4.0 concepts and technologies will lead to an increase in mass customization and personalization, structural changes in labor market, and eventually economic growth. I4.0 Maturity Models can help companies and organizations to identify and map their current capabilities with future prospective to-be state in different domains. However, there is a research gap in the area of Maturity Models tailored towards ML implementation. In that sense, this research work aims to develop a novel Machine Learning Maturity Scale (MLMS) framework that integrates the general components and attributes of ML development and lifecycle management based on the analysis of I4.0 maturity models.*

Keywords: Machine Learning, Industry 4.0, Maturity Models, Lifecycle Management, Digital Transformation

1. Introduction

The concept "Industry 4.0 (I4.0)" was first introduced by the German federal government in 2011 as a strategic development plan for German industry, based on a unification in single information space of industrial equipment and information systems, which will allow them to interact with each other and with the external environment without human intervention [1]. The main idea behind I4.0 was suggested as the integration of so-called cyber-physical systems (CPS) and Internet of Things (IoT) into industrial processes, or automated machines and processing centers connected to the Internet [2], [3]. Applying the concepts and technologies of I4.0 will imply an increase in functionality, flexibility of production processes, transparency and customization of products and services provided for customers, and globalization and adaptability of the supply chain [4].

Different manufacturing industries are now achieving great benefits by implementing I4.0 concepts such as Machine Learning (ML), Internet of Things (IoT), Big Data, and Cloud Computing in their operation. ML is a concept that implies learning based on finding patterns in data and then applying this knowledge to provide the prediction or prognosis of results [5]. It is one of the fundamental concepts of I4.0, defined to provide the increase in efficiency and effectiveness of enterprise processes and operations via analytical model building and finding patterns and characteristics in data models using different algorithms [6].

There is a research gap in the area of maturity models tailored towards ML implementation. In that regard, this research focuses on the concept of ML in the I4.0 paradigm. It is one of the essential aspects of the new industrial revolution. Considering this, it is crucial to adopt ML in business and enterprise processes correctly. I4.0 paradigm that involves adopting cutting-edge technologies is especially promising for the implementation of ML by companies and organizations. It necessitates the maturity assessment of companies to provide a roadmap towards

digitalization and high-level ML implementation [7]. Maturity or readiness assessment models are commonly accepted tools devoted to measuring the as-it-is state of the company’s progress towards the target state regarding process improvements [8].

If one has an understandable maturity scale in front, it is easier to understand the current position and respective future states ahead. Moreover, it will allow to decide on priorities and start adjusting the requirements and needs of the companies and organizations based on the results of the maturity assessment, thereby providing the foundation of sustainable development of business and enterprise processes [9].

This research work aims to develop a novel Machine Learning Maturity Scale (MLMS) framework that encompasses the general characteristics and traits of ML development and implementation based on the analysis of I4.0 maturity models.

2. Literature Review

2.1 Overview of Maturity/Readiness Assessment Models

To start with, a general overview of the current state of maturity models is required to understand how they are being implemented and used. One way to facilitate the companies towards digital transformation is to assess their maturity level in implementing digitalization tools, strategy, processes, products, and services.

The Maturity Model is a structured framework for identifying the current maturity status of a subject by a set of criteria. It can consist of several dimensions, each of which will identify and measure a particular set of characteristics and items of a subject in that particular area. In other words, maturity models can be used to consider and classify capabilities under a specified particular domain [10]. The development framework of the majority of I4.0 maturity models are based on CMMI, ISO, PMI and COBIT principles [11]. There are already several I4.0 Maturity Models with differentiated focus and development areas. Table 1 has presented the overview of some of the existing I4.0-related maturity/readiness assessment models.

Based on the analysis of six maturity models related to I4.0 implementation, it is clear that the models tailored explicitly for ML implementation are not widely presented. Although there are several practically useful commercial models for measuring the status quo of I4.0 maturity such as Digital Operations Self-Assessment, Acatech Industrie 4.0 Maturity Index, and IMPULS Readiness Model, they fall short of focusing on the ML adaptation and implementation.

TABLE I. Overview of Maturity/Readiness Assessment Models

#	Model name	Readiness/maturity dimensions and levels	Review comments
1	Digital Operations Self-Assessment maturity model [12]	<p><u>Six dimensions:</u> Business Models, Products & Service Portfolio, Market & Customer Access, Value Chain & Processes, IT architecture, Compliance, security, legal & tax, Organization & Culture.</p> <p><u>Four maturity levels:</u> Digital novice, Vertical integrator, Horizontal collaborator, Digital Champion.</p>	<ul style="list-style-type: none"> • Provides clear explanations of I4.0 capabilities needed to reach each maturity level across six dimensions • Has an online self-assessment tool • Lacks details on maturity assessment approach • Offers only general I4.0 maturity assessment

#	Model name	Readiness/maturity dimensions and levels	Review comments
2	Acatech Industrie 4.0 Maturity Index [13]	<u>Four structural areas:</u> Resources, Information Systems, Organizational Structure, Culture. <u>Six maturity stages:</u> Computerization, Connectivity, Visibility, Transparency, Predictive capacity, Adaptability.	<ul style="list-style-type: none"> • Provides clear explanations of I4.0 capabilities needed to reach the highest level of maturity in each structural area • Provides an overview of the design of the model and the maturity assessment approach • Lacks details on maturity assessment tools (questionnaire, weighting method, etc.) used in the model • Offers profound maturity assessment
3	IMPULS Readiness Model [14]	<u>Six dimensions:</u> Strategy and organization, Smart factory, Smart operations, Smart products, Data-driven services, employees. <u>Five readiness levels:</u> Outsider, Beginner, Intermediate, Experienced, Expert, Top performer.	<ul style="list-style-type: none"> • Provides clear explanations of I4.0 capabilities needed to reach the highest level of readiness across six dimensions and five readiness levels • Clearly indicates main hurdles and actions to reach a higher level of I4.0 readiness in each dimension • Has an online readiness self-check tool • Lacks details on readiness assessment approach • Offers general maturity assessment
4	Big Data Maturity Model (BDMM) [15]	<u>Four maturity dimensions:</u> Strategy, Processes, Analytics, Management, People, Culture, Governance <u>Five maturity stages:</u> 5-Likert Scale (Level 1 to Level 5)	<ul style="list-style-type: none"> • Provides brief explanations of Big Data capabilities and activities needed to reach each level of maturity. • Concrete details on maturity assessment approach and tools used in the model • The model has been tested and validated • Offers maturity assessment of Big Data implementation and management
5	DREAMY (Digital Readiness Assessment Maturity model) [16]	<u>Five process areas:</u> Design and Engineering, Production Management, Quality Management, Maintenance Management, Logistics Management. <u>Five maturity levels:</u> Initial, Managed, Defined, Integrated and interoperable, Digital-oriented.	<ul style="list-style-type: none"> • Provides brief explanations of I4.0 capabilities corresponding to each maturity level • Lacks details on maturity assessment approach and tools used in the model • Offers general maturity assessment
6	M2DMM – Maturity Model for Data-Driven Manufacturing [17]	<u>Six maturity features:</u> Data Storage and Compute, Service-oriented Architecture, Information Integration, Digital Twin, Advanced Analytics, Real-time Capabilities. <u>Six maturity levels:</u> Nonexistent IT Integration, Data and System Integration, Integration of Cross-Life-Cycle Data, Service Orientation, Digital Twin, Self-Optimizing Factory.	<ul style="list-style-type: none"> • Provides brief explanations of I4.0 capabilities corresponding to each maturity dimension and level • Lacks details on maturity assessment approach and tools used in the model • Offers maturity assessment of IT architecture for data-driven manufacturing

2.2 Overview of Management Approaches of Machine Learning Models

The concept of ML is widely presented in the literature and this sphere is continuing to evolve further. [18] put forward the claim that implementation of ML models follows the value chain

lifecycle as a regular business process, therefore there is a considerable need to classify and conceptualize the lifecycle management systems in the ML sphere. This view is supported by [19], who state that the lifecycle management of ML models and other business process management approaches are similar. Moreover, they have provided the lifecycle of the developed Model Management Platform for I4.0, which consists of several aspects:

1. Planning the model structure and architecture: this step considers the identification of requirements and criteria, and documentation of the whole project development.
2. Building the model and testing: this step includes the first deployment of the prototype model to configure final results meeting the derived criteria; if the criteria and requirements are not met at this stage (checking the feasibility), then the continuous improvement of the model characteristics are being implemented.
3. Deploy of the model: this step is a logical continuation of the previous one, when the model is being deployed in the natural working environment with the changes and alterations made during the continuous and iterative approach on the previous stage.
4. Usage and Monitoring of the model: at this stage, the resulting features of the model are being monitored and analyzed with the target values (whether the error margin is in the acceptable region or not, whether the features selected are representative or not, etc.).
5. Retiring the model: this is the final stage where the model meets the end of the value chain due to various external and internal factors such as changes in the criteria and requirements, degradation of the target results, and obsolescence of model features.

A compelling helicopter overview of value chain processes of ML models with their lifecycle stages and processes (see Fig.1) is provided by [20]:

1. Defining the main requirements: this step is similar to one described by [19], which is aimed to define and formulate the main requirements of the ML model.
2. Data Management: this cluster includes several steps and procedures such as data collection, augmentation of data points in a concise and consistent manner, preprocessing of data collected by applying different techniques and tools (outliers, normalization of data points, cleaning data entries), and exploratory data analysis.
3. Model Learning: this step requires obtaining the testing data for further processes and procedures such as model selection (appropriate ML model that is based on the requirements and state-of-the-art (SOTA) for that approach), training of the model (choosing the batch size, deriving validation and verification datasets), transfer learning (transferability of learning parameters of the prototype to the final version of the model), and hyperparameter selection (choosing appropriate and valid hyperparameters for the ML algorithm).
4. Model Verification: this step is aimed to verify training results on a separate set of data (verification dataset) and formally assuring the feasibility and applicability of model results, thereby providing the generalization process. It includes several steps such as formal verification (meeting the crucial criteria and requirements derived at Stage 1), test-based verification (comparing the obtained results with target ones with different tools including loss function), and requirement encoding (checking if the results of loss function comply with derived requirements and criteria). The output of that stage is the verification result which provides the necessary base for further implementation of the final version of the model.
5. Model Deployment: the main aim of this step is to provide the integration of developed ML model into existing enterprise systems and processes, thereby comprising the procedural steps such as integration (implementing systems engineering methodologies), monitoring (continuous monitoring of ML model implementation), and updating (updating the model characteristics through continuous improvements made).
6. MAPE Framework: this framework is a procedural stage that combines Monitoring, Analysis, Planning, and Execution (MAPE) processes of the model in a control loop. It is

necessary to provide up-to-date characteristics of the model to ensure meeting the crucial requirements and minimize the value of loss function (difference between target results and obtained ones).

A similar approach is described by [21], who put forward the claim that end-to-end ML model pipeline is consisting of the similar steps discussed above: starting from data management procedures (data cleaning, data preparing, and augmentation) up to the derivation of model training results via representing values (loss function, margin of error, etc.).

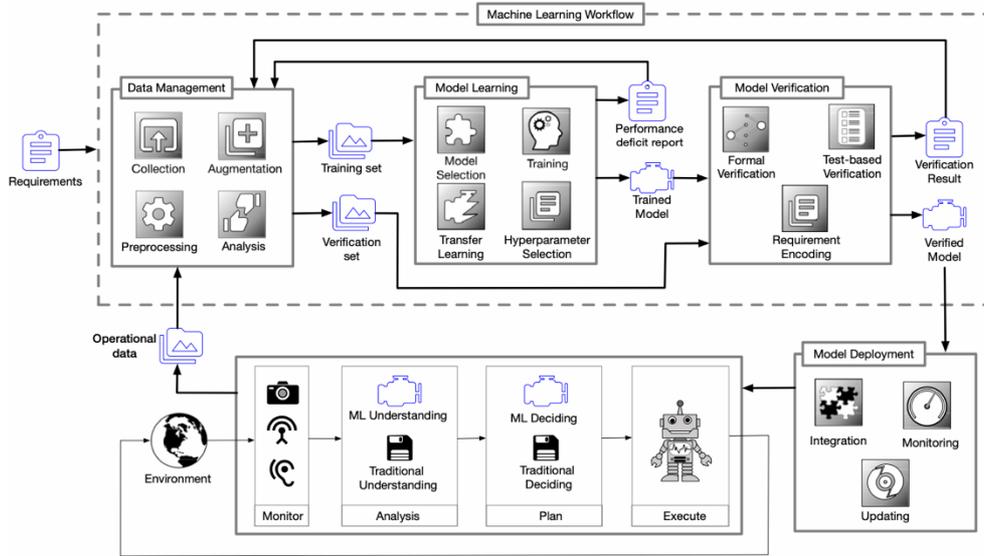


Fig. 1. The Machine Learning Lifecycle [20]

Another perspective on that matter is provided by [22], who contributed to the ML lifecycle analysis in the context of IoT applications by underlying the contextual interrelation between these two concepts. In addition, the taxonomy of ML-based IoT applications developed by the authors highlighted similar aspects discussed by other researchers: Model Development, Model Deployment, Model Audit, and Data Acquisition have a high level of correspondence with conventional ML lifecycle management.

In summary, the compelling number of research works considered have provided a strong claim towards the unified concept of lifecycle management and value chain processes of ML models. On these grounds, the further development of MLMS framework is provided.

3. Development of Novel Machine Learning Maturity Scale (MLMS) Framework

Since the main objective of this paper is to create the assessment framework for the ML implementation by companies and organizations, the new MLMS framework was developed, which aims to provide the description of maturity scales of ML adaptation and implementation.

MLMS is consisting of the 5-Likert Scale:

1. Level 1 - Entrant
2. Level 2 - Beginner
3. Level 3 - Learner
4. Level 4 - Integrator
5. Level 5 - Expert

Level 1 - Entrant

This level represents the starting point for companies and organizations in their journey towards ML adaptation and implementation. The company does not have any initiated ML-related strategy. Moreover, no collaborations and innovative organizational systems are established. ML development processes are not structured and lack proper hierarchy and architecture. As well, due to the absence of highly qualified professionals and lack of personnel development programs, no formal transfer learning (experience learning) is applicable throughout an enterprise. As a result, it prevents the proper control and management of the processes and efficient decision-making. At this stage, the company lacks a properly developed data management system. Additionally, ML processes in the organization are not standardized and lack a proper lifecycle management approach. In such cases, third parties are involved in the application and development of ML in the company. Finally, products and services provided at this point are not fully supported by ML, while the companies' requirements and criteria are under continuous changes. Overall, this is a starting point for the majority of companies and organizations.

Level 2 - Beginner

At this level, the company's management is aware of ML and its possibilities. The company initiated some elements of ML within the scope of its corporate strategy. However, the company has not created separate ML performance metrics. ML development architecture is isolated and centralized, while ML processes are managed only within separate functions (silos). Also, the primary function of the ML implementation is to provide support to the firm in the integration and sustainable development of existing enterprise systems. Slight automation and integration of some ML processes are available such as data acquisition. Datasets for ML are stored on the centralized database system. As a result, the enterprise's ML operations and processes are not fully integrated with the local enterprise systems. Enterprise's data is utilized on a low level in the company, while the ML usage provides low-level upgradability of products and services of the company. Some ML processes are managed on the level of silos, however standard procedure for similar functions is absent. In order to achieve regular and repeatable results, a more systematic approach is required to be applied. The process of primary systematization is prepared to comprise at least the followings at this level [23]:

- Systematization and generalization of task setting: there may be a lack of full-fledged task tracker, backlog, and so on, but at least there is already a process for prioritizing tasks.
- Separation of duties: at least dedicated employee roles (e.g., data architect, data engineer, data scientist, machine learning engineer) are being derived. This component is accountable for the general success of launched projects related to ML.
- The emergence of primary regulations for applying the results of ML models is taking place. It should be noted that it is not the regulations for applying ML models but for applying the results of ML models [20].

In general, it can be concluded that the company already made the first steps towards ML implementation, and now the process of learning and transforming is awaiting.

Level 3 - Learner

At this stage, the company formulated an ML implementation strategy and developed ML performance metrics within general measurements. The company has a ML department, which built interconnected and networked architecture for ML deployment processes. Automation facilitates the increase in the level of integration of ML processes with enterprise systems. This enables the monitoring and control on the production development level. Enterprise data (including ML datasets) is stored on the firm's local servers, not in cloud systems, and is used at moderate level in decision-making processes. The organization has ML quality control measures that are implemented in accordance with industry standards and best practices. The company can

provide the limited customization options available at the initial stages of ML development and production. Also, the products and services of the company are situationally upgraded with the help of ML to meet critical requirements and criteria. Additionally, the company enhances the development of the employees' digital skills related to ML at different levels. The developed ML models are not merely trained and tested, but the regularity of their launch arises, and regulation for applying the results is derived. Therefore, there arises a crucial need for providing monitoring, control, and analysis on an ongoing continuous basis:

- Evaluation of input data: the data should be evaluated both in terms of data quality (empty fields, erroneous variables) and distribution of data points. Eventually, if there will be a difference between the distribution of training data and validation data, then the relevance of ML model results is under enormous and arguable consideration, thereby necessitating to re-think about retraining the model [20], [24].
- Accuracy of ML model: the company should have an understanding of how the model prognosis results will be compared with post factum ones [22], [24].
- The economic effect of ML model: the company should consider all the relatable financial and economic aspects of the model, based on which to provide effective decision-making of future ML development [20], [24].

Overall, the company at that level is considered to be much more developed from the perspective of ML implementation.

Level 4 - Integrator

The companies at this level already put some investments into pilot initiatives. As well, partial implementation of the ML strategy with related metrics set up and monitored. Enterprise has a ML development architecture with dedicated department responsible for it. Enterprise's ML production and development status can be monitored on the enterprise level, while ML production operations and processes are moderately automated. ML models are highly integrated with enterprise systems. The company utilizes cloud solutions for high-level purposes such as cloud computing. Moreover, enterprise data (including ML datasets) is digitized and stored in a central database system accessible on the end-to-end vertical integration level. Products and services of the company can be significantly improved with ML implementation. Besides that, the company allocated a budget for training to enhance digital skills and qualification in the sphere of ML for the majority of the employees. With the increase in the number of ML models being put into production operation, there will eventually be a threshold value of ML impact on the company's business performance [25]. In that regard, the main focus areas are following:

- Equipment and Assets: ML models at that stage should be developed with separated production stages with appropriate equipment and assets (development, testing, production).
- Procedures and regulations for providing ML models into production, retraining, and so on: this particular aspect should be documented, described, and appropriately standardized.
- A balance between sustaining and supporting currently existing processes and introducing newly emerged ones.

Overall, companies at that level are considered as the industry leaders, and they are on their way to developing new standards and regulations in the sphere of ML.

Level 5 – Expert

Top performer company has established and implemented ML strategy across the whole organization's processes. The company made significant investments in ML systems. It has strong support for all ML systems and processes and has advanced ML development architecture. The majority of enterprise data is used for ML development procedures (training, testing, and

verification datasets). ML production and operation processes are fully automated with enterprise automation systems. Data is digitized and stored in a single cloud with end-to-end vertical integration access. This allows monitoring the production and development status in real-time throughout the ML lifecycle and value chain. On top of that, the data is heavily used on advanced level decision-making, for example, to refine the business model on an enterprise level. Products and services of the company are upgraded regularly with the help of ML to enhance their value. Product recommendation services or other advanced data-driven ML services are available. Finally, the organization has strong collaborations with universities, research institutions, and similar intellectual organizations.

This is a further step along the ML maturity logically complementing characteristics and steps described in Level 4. In addition, it is directly corresponding with building and developing fully-fledged DataOps [26] and MLOps [27] practices to automate and systematize the processes of ML development and deployment. Moreover, it implies constant and systematic monitoring of all ML models in production from diversified aspects.

4. Conclusion and Implication for Further Research

This article identified the overarching concepts, characteristics, and enabling aspects of ML that are devoted to establishing a common understanding among various literature sources available. Moreover, it attempted to provide an overview of ML lifecycle management and value chain processes and incorporating them into a novel MLMS framework in the context of evolving and maturing I4.0 concept. The literature review of available maturity models was provided to understand the current state of maturity model development. To truly comprehend the momentum for ML development and integration into existing enterprise systems and processes, the panoramic view of ML maturity levels in the 5-Likert Scale has been developed. The framework of this study might complement the research on the development of ML ontology.

The further research implications include developing a maturity model framework with defined dimensions and sub-dimensions, as well as developing the context and characteristics of maturity model implementation. Another important aspect will be to provide the assessment methodology potentially incorporating different tools and techniques for solving multi-criteria decision-making problems such as Bayesian Best-Worst Method and Analytical Hierarchy Process.

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AUTO-REFINING RECONSTRUCTION ALGORITHM FOR LIMITED ANGLE HUMANOID RECONSTRUCTION IN HOLOGRAPHIC TELECONFERENCING APPLICATIONS

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Abstract: *One of the major hurdles in the field of 3D object reconstructions is complex temporally morphing object reconstruction. With the majority of research leaving this knowledge gap by focusing on only on static object reconstruction. In our research, we present a deep adversarial neural network architecture capable of denoising and refining real-world depth sensor inputs for object reconstruction. The proposed method is capable of cleaning up the pointcloud input and making synthetic-like. We found that the suggested approach is able to reconstruct the full human body with as much as 60-70% of the depth information being occluded. This makes it an attractive solution for the holographic teleconferencing applications. When evaluated quantitatively it has achieved Chamfer and Earth Mover's distance metrics of 0.059 and 0.079 respectively. This makes it on-par with self-reported reconstruction with other state-of-the-art approaches in terms of reconstruction quality. Meanwhile, our approach is capable of complex and temporally morphing reconstruction from real depth inputs.*

Keywords: pointcloud reconstruction, holograms, teleconferencing, adversarial auto-refinement, human shape reconstruction

1. Introduction

One of the most rapidly evolving research fields, thanks in large part to the advancements in artificial intelligence, is computer vision. While in the past visible light spectrum cameras have been used to solve various computer vision tasks, we are entering the time period where even the home user has an access to to depth scanning system from their handheld devices. The addition of the third perspective (depth) allows us to solve various real time object detection tasks, one of which is object reconstruction. Object reconstruction allows us to improve a lot of various computer vision related fields, starting with collision avoidance in autonomous vehicles [1, 2], robotics, [3, 4], remote learning, teleconferencing [5] or even applications in the medical field for example tracking and helping to maintain good posture [6, 7]. In our research we propose a novel three staged adversarial auto-refining deep neural network, which is capable of reconstructing full human body posture with as much as 60-70% of the input pointcloud being occluded. Our approach was able to achieve 0.059 and 0.079 Chamfer and Earth Mover's distance metrics respectively. Achieved results are on-par with other state-of-the-art approaches in terms of reconstruction quality; however, unlike others we have achieved a complete sensor-to-screen reconstruction without externally provided masking information for the given input frame.

2. Related Works

Due to advancements in artificial intelligence, deep neural networks have been applied to solve various tasks. One of such tasks is the 3D object reconstruction. There exist two primary ways to reconstruct a three-dimensional object, these are voxels and pointclouds. One of the most well-known voxel-based solutions is 3D-R2N2 [8] which has used a priori knowledge to predict the

objects shape either from a single or multiple-perspective frames. 3D-R2N2 has used deep recurrent neural networks, specifically Long Short-Term Memory (LSTM) gates, in order to learn the objects representation by being shown multiple perspective views during training process. While it has shown great predictive capabilities, it suffers from one major flaw – it requires external help in order to mask the object that we want to reconstruct. This makes it unfeasible for real world application. One of the solutions [9] to resolve this problem also used voxel-based approach for the reconstruction; however, it has instead merged its reconstruction task together with object recognition by extending the YOLO network architecture. This allowed it to work as its own standalone entity and create a full objects reconstruction from a single captured camera frame. Unfortunately, voxel-based solutions are not scalable to objects that require high granularity, due to their huge operating memory overhead. To solve this issue, pointcloud-based reconstruction has been proposed instead, with one of the pioneers being PointOutNet [9]. However, training on an unsorted pointcloud data is extremely difficult because standard neural network loss functions are no longer applicable. As a solution, PointOutNet suggested to use Earth Mover’s and Chamfer distances as ground-truth and validation metrics. Despite it using flat input images to perform the object reconstruction it has shown great potential, yet flat images lose valuable depth data which can be used to improve the results. Following this research, PointNet [10] which has attempted to reconstruct the objects using unstructured pointclouds as an input. One of the issues when dealing with unstructured inputs is the fact that we can no longer use such kernel functions as 2D or 3D convolutions, as the neighbor features are no longer correlating with each other, to solve this symmetric learning functions have been proposed instead. This has allowed the network to fill in the missing chunks for malformed pointcloud inputs. Further research has improved the reconstruction quality, PCN [11] has proposed a coarse-to-fine methodology, which first reconstructs the coarse object features, followed by further refinement using residual latent vectors. Further developments in the field have been by AtlasNet [12] by introducing patch-based reconstruction. This allowed the individual 2D patches to map onto parametric 3D object groups forming the closed shape. Despite PointOutNet having suggested the use of Earth Mover’s distance for the loss metric, it has been used only as an evaluation metric due to prohibitively expensive $O(n^3)$ memory complexity. MSN [13] has suggested an approximation of EMD in addition expansion penalty, that forces the points to more evenly distribute on the shape.

3. Proposed Adversarial Solution

One of the issues when dealing with real-world depth sensors is their inherent unreliability in terms of the depth quality. Both structured light and laser based sensors have serious distortions and deformations in the scanned depth field. Even though, state-of-the-art approaches have shown great results in terms of reconstruction, they tend to perform experiments only on synthetic datasets; thus, when given real world depth frame they tend to fail completely. One of the solutions, to solve this issue, would be introducing real world examples into the training data set. However, such datasets are generally rare and flawed, due to the research field being relatively new. Meanwhile, creating such dataset from scratch would be prohibitively expensive, as it would require creating ground truths for each of the filmed frames manually.

To solve the synthetic and real-world dataset discrepancies, we have devised an unsupervised machine learning approach capable of object reconstruction without having ground truth values for object reconstruction. The overview of our approach can be seen in Fig 1.

During the first step we take the depth sensors, either structured light or laser, input and combine with the camera’s intrinsic matrix K , this produces an appropriate pointcloud. This is possible because depth sensor has identical perspective distortion as would a pinhole camera.

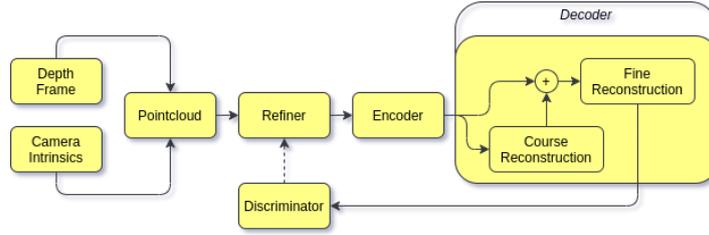


Fig 1. Neural network architecture overview

Afterwards, we reduce the pointcloud dimensionality to 2048 using random sampling with uniform distribution, as the original input would have too high of a dimensionality to be usable on modern hardware. The down-sampled pointcloud is then used as an input in the refinement network. The refiner is a convolutional auto-encoder network which tries to compress and decompress information through a bottleneck; thus, leaving only the most important features, our bottleneck is of size 256. As we use both real-world and synthetic datasets in the auto-encoder phase, the network attempts to find similar features between both datasets that can be later used for object reconstruction. This process gives us two outputs: inputs latent features and cleaned up pointcloud.

Once we have performed the refinement step we are ready for reconstruction stage. Just like the refinement stage, reconstruction stage is an asymmetric multi-stage auto-encoder. During the reconstruction stage we extract 256 most sensible latent feature vectors from the refined input and concatenate them with the previously extracted refiner latent features giving as a combined feature vector that we can use for reconstruction in the decoding phase. Additionally, the concatenated features also encourage the neural network to keep the initial objects features, this acts as a constraint.

Following this, a patch based approach is used for the coarse objects feature reconstruction. As suggested by Liu et al. [13], we perform a patch based coarse feature reconstruction, where 8 random tightly bound patches are created in grid like fashion which are then trained to spread on the objects surface. The resulting coarse feature pointcloud is connected with the refined pointcloud output using residual connections, where further neural network refinement takes place, producing a fine-grained objects pointcloud reconstruction. Unlike the refinement stage, that is trained on both synthetic and real-world datasets, reconstruction training is performed only using synthetic dataset.

Once the fine reconstruction is complete, we can use it in the discriminator phase. Discriminator phase, is our auxiliary network that performs unsupervised adversarial training. During this phase, the discriminator takes fine pointcloud as an input and attempts to predict which dataset the input pointcloud has belonged, outputting “1” for synthetic dataset and “0” for real-world dataset. The discriminator attempts to adjust itself so that it is always correct in identifying which lass the pointcloud belongs to; meanwhile, the refiner uses the inverted discriminator loss in an attempt to adjust its output so that it would manage to deceive the discriminator. This adversarial fight trains the refiner to output pointclouds indistinguishable from synthetic ones; thus, cleaning up the resulting output.

4. Results and Conclusion

We have proposed a three-staged adversarial auto-refining neural network, that is able of full human body reconstruction using both real world and synthetic depth frames. It has achieved accuracy metrics of 0.059 EMD and 0.079 CD. This suggests that our solution can compare with the state-of-the-art approaches in terms of reconstruction quality. Despite the quantitative parity,

it has managed to completely outperform them in terms of real-world application for object reconstruction tasks. Our proposed solution can be easily applied in various fields ranging from robotics to remote work, teleconferencing and even holographic technologies by not only reconstructing the full human body with as little as 30-40% of the body being occluded but also saving on the initial setup cost that a full body scan setup would entail.

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IMPACT OF COVID-19 VIRUS ON IT ORGANIZATIONS: A STUDY OF A VIRTUAL WORKING SYSTEM

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Abstract: *This paper investigates the impact of COVID-19 on organizations and a study on employees' working behavior and working system. Currently, all around the world, IT (Information Technology) organizations are enabling virtual and digital communications. An overview of the remote working system including the pre- and post-corona effects on the communicating system, its productivity, and how efficiently the employees are flexible with the virtual working system. Overall, this paper includes different research on how working remotely influenced divergent organizations and a brief description of how digital transformation integrates amidst COVID-19. As the current situation is unpredictable and the employees struggle with their organization culture, we suggest that virtual organizations should conduct certain cultural activities at least once a week during online meetings to help employee's savior their work.*

Keywords: virtual organization, COVID-19, SARS-CoV-2, remote working system

1. Introduction

COVID-19 is a deadly infectious disease which is also called Coronavirus. This disease was first raised in Wuhan, China, in 2019 on 30 March 2020. As it was contagious diseases it got spread from person to person through touch, cough, etc., and it got widely spread to 203 countries all around the world and declared as a global pandemic officially and few countries have strict rules and regulations to control this pandemic and the countries implemented the lockdown system to get control of the diseases. Local transmission of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) are experienced by multiple countries in the first wave of COVID-19 epidemic in India. Currently, the Coronavirus second wave is demolished the whole population within the country and with the help of scientists, the vaccination is coming into pavilion such as COVAXIN and COVIDSHIELD and other formulae doses are in progress to eradicate these diseases [1].

On 30 January 2020, the emergency committee from WHO (World Health Organization) declared a global health emergency based on growing on the Coronavirus diseases from person to person, the notification rates at Chinese and in international locations [2]. This global pandemic disrupted the way organizations function and it shattered the whole world. In these circumstances, the digital transformation like work styles has gathered a lot of attention and it also helped in the spread of IoT, AI, 5 G, cloud services, etc. is further quicken this digital transformation [3]. Under the conditions brought about by COVID-19, "remote working offered greater flexibility for teams to manage their obligations, for example, frequent check-ins with supervisors and management while being compliant with government social distancing restrictions" [4].

In the COVID-19 pandemic, most of the organization's commute to working from home and usage of different tools which will help in communication and connecting with employees all around the globe effortlessly. Considering the health crisis of all people within the firm substantial aspects are implemented all around the world. organizations because of employees and goodwill of both management of the company and employees adopting the contemporary digital

transformation tools for the development of the business efficiently from each corner of the globe [5].

Generally, before the pandemic, only a few organizations are working remotely but now due to the current Coronavirus, totally all over the world enabling Virtual organizations. The large-scale economic upheaval brought by the Coronavirus, this abrupt transition leads to the organization co-ordination, Decision-making processes, and productivity has never been more consequential and changed to work from home. The global policy all around the world responds to the COVID-19 which represents the unprecedented experiment for the first time and organizations themselves have dispersed the physical workforce and employees had to rely on digital communications (Online Communication Tools) to connect with the organization meetings and to accomplish another task [5].

Digital communication like E-mails and meetings are used to compensate the lack of face-to-face conversation that typically takes place at physical workplaces, employees will lack direct communication to the people and the environment change which indeed creates the productivity of work depends on the surroundings. The employees are communicating with the organizations with the help of online communication tools. The usage of these communication tools is rapidly increased now, and these are also used in other ways for Distance Education of bachelor's & master's degree, Schools, Interview Sessions, and general meetings [6].

2. During COVID-19, Organizations Migrated to Digital Transformation on a Worldwide Scale

A Major focal point of the organization strategy includes the securing of advanced technology and commencement of computerized stages. Withstanding the difficulties introduced by the COVID-19 pandemic, the inescapable spending on computerized change technology advances, and administration use is incremented [9]. Constantly seven days stretch of March 2020, contrasted with the normal downloads each week in the final quarter of the most recent year, the downloads of Zoom© were multiple times higher in Italy, 27times higher in Spain, 20 times higher in the UK, and multiple times higher in the United States [10].

COVID-19 pandemic has made every to work from home for all narration and notion but still, there is a standard workflow among all the workers and manifest about how the workers changed their daily routine due to pandemic. Before Coronavirus, the organizations are well and good in all aspects in a positive way but now there is a lot of drawbacks in the working system not only a lot of issues in other areas too. These conditions lead to a huge usage of online meetings and exchange of E-mails all around the globe in fields to connect with the corresponding people, and the work is accomplished remotely. With this drastic change in the exchange of information through online meetings and e-mails the activities, frequency, and the composite and recipients are rapidly increasing in these areas.

The analysis about the increase of this digital transformation platform on meetings and E-mails of users 3,143,270 across 21,478 de-recognized corporations in 16 metropolitan cities from the USA is provided by the level of Metropolitan Statistical Area (MSA) per day overall all around the organizations [5]. By and large, the representatives in any association invest their energy generally on gatherings, that differ freely like an absolute number of gatherings, normal gathering span and so on. Subsequently, there is an increment in the gathering meetings for a representative each day. [5] investigates between the Meetings and the E-mails dependent on the Lockdown days and portrays the gathering length at the lockdown and the base weeks utilizing the relapse investigation led an adjustment of advanced correspondence designs by week [5].

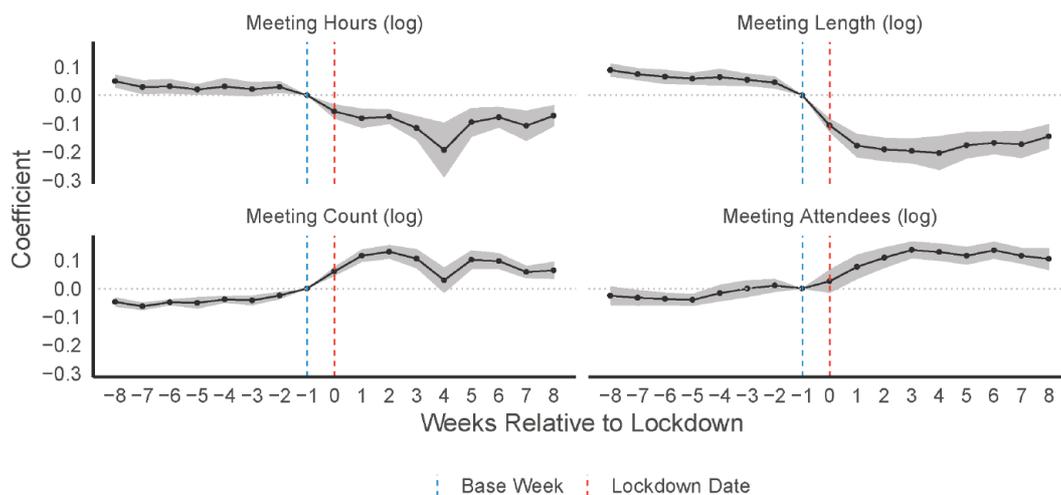


Fig. 1. Impact of COVID-19 Lockdown on Meetings [5]

3. Pre- and Post- COVID Remote Working System

Remote work implies that employees are working structurally outside of a traditional office environment and advanced work methods are introduced around services and participation [4]. Erik Brynjolfsson, et al, [6] performed a survey about the remote working system from a U.S firm organization which states that before COVID-19 none of the employees worked properly. On the whole, 13.2% of the represented workforce are working at home and 2.3% of hiring managers had worked remotely. Predictably, the remote work has been increased up to 94%, and more employees feel like the remote working is satisfactory, but the few employees felt it was worst. They also stated that remote work includes the lack of communication from person to person, unnecessary meetings at the workplace, and it also reduced distraction at the office and overall, the corresponding employees virtual working system are analyzed are shown in the below table [6].

TABLE I. Analyzed remote working system Pre- and Post-COVID-19 in US [6]

	<i>Pre-COVID</i>	<i>Post-COVID</i>
No remote workers on their team	46%	6%
Fully remote team	2.3%	20%
Share of their workers remote	13.2%	56% to 74%

4. Efficiency of Remote Working System During COVID-19

The COVID-19 pandemic had direct and indirect effects on the upstream and downstream business transactions. The pandemic has raised pressure in most organizations where companies struggle to cope with different unpredictability. In the below figure, a survey performed by Trust Radius [7], on June 9, 2020, with 1,130 respondents on tech employees working remotely states that mostly 57% of the respondents are extra effective when compared to working in the office before the 2020 COVID-19 pandemic. unexpectedly, 17 % of tech employees respond that they were less effective with a remote working system [7].

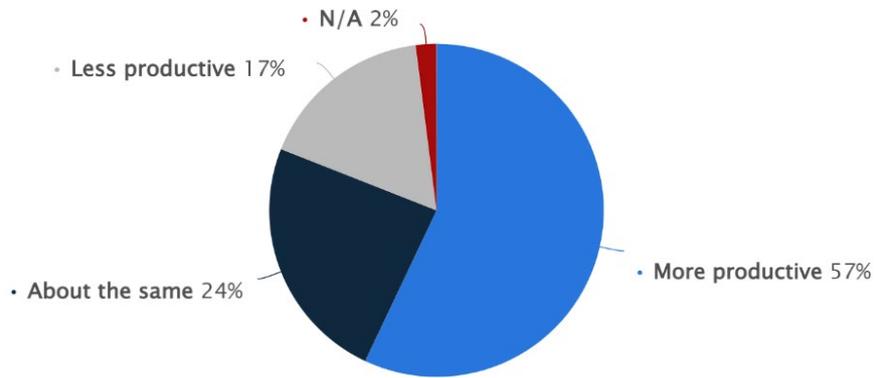


Fig. 2. COVID-19 pandemic's effect on tech employee's productivity levels with WFH 2020 [7]

- **Measures of Employee Productivity:**

Organizational culture can have a positive or negative impact on motivation and performance in general. Positive culture, according to Yildirim et al. (2016), boosted employee performance and commitment. Employees are encouraged to accomplish their jobs with vigor and passion in a productive culture. As a result, it is possible to conclude that organizational culture is linked to job satisfaction, commitment, and performance. The following are some organizational elements that could boost [11].

- **Employee Productivity:**

Many organizations have discovered in recent years that it is critical to focus on activities that motivate their staff to achieve corporate goals. This is because motivation improves worker productivity and performance while also enhancing workplace involvement by making the work more important and engaging (Kamery, 2004; Ekerman, 2006).

- **Communications:**

Successful communication allows an organization to have excellent coordination among its teams or units whereas its absence will imply problems with company activities or, more importantly, cause harm/conflict among personnel [11].

- **Job Stress:**

Workplace stress occurs when people are unable to organize available resources and task requests within their respective capacities. In other words, some firms may insist that employees complete a specific amount of work, yet their employees may be unable to adjust to the tasks at hand. It is believed that demands exceed a person's capacity, resulting in top administrators becoming unsatisfied. Workplace stress has also been labeled a social issue (Mizuno et al., 2006) that combines several factors that interfere with workers' physical and mental abilities as well as their health care (Conway et al., 2008).

Implementing a four-day workweek, which is not a new concept, is another technique that organizations could use to boost staff productivity. France, for example, implemented a reduction in working hours nearly 20 years ago to improve the country's work-life balance. In addition, Canada, the Netherlands, and New Zealand have all experimented with the idea of a four-day workweek, with positive results. They are, in fact, attempting to make these reforms permanent. Furthermore, when UK company pioneers allowed some of their full-time reps to work four days a week, they saw an increase in employee satisfaction [11].

They also noticed an increase in employee efficiency and output, as well as a decrease in staff turnover (Laker and Roulet, 2019). There is unmistakably a link between a four-day workday and increased personal satisfaction (Laker and Roulet, 2019). However, because the demands of

various institutes must be evaluated and studied further, the concept is not yet generally acknowledged or adhered to a reduced workweek, however, may prove to be beneficial because to its claimed success, especially considering the present COVID-19 pandemic's lockdown and social separation tactics [11].

5. Striving with Virtual Organizations

In this digital world, organizations are adopting new technologies which will help in the development of business and apart from this in this epidemic situation employees are not cooperative with the remote working system. As employees who are working from home will not have the office environment such as a table, chair, etc., also need to cope up with the lack of company culture and supervising the family people with no traditional meetings which lead to the distress and health crisis. Therefore, remote working system for employees experience a conflation between their workspace and the living area, and the important aspect is finding ways to stabilize their professional schedules with their private lives in some cases to overcome few things. The common aspect is due to the online meetings they face network issues and difficulties with collaboration and communication since they are not working in the office space [12].

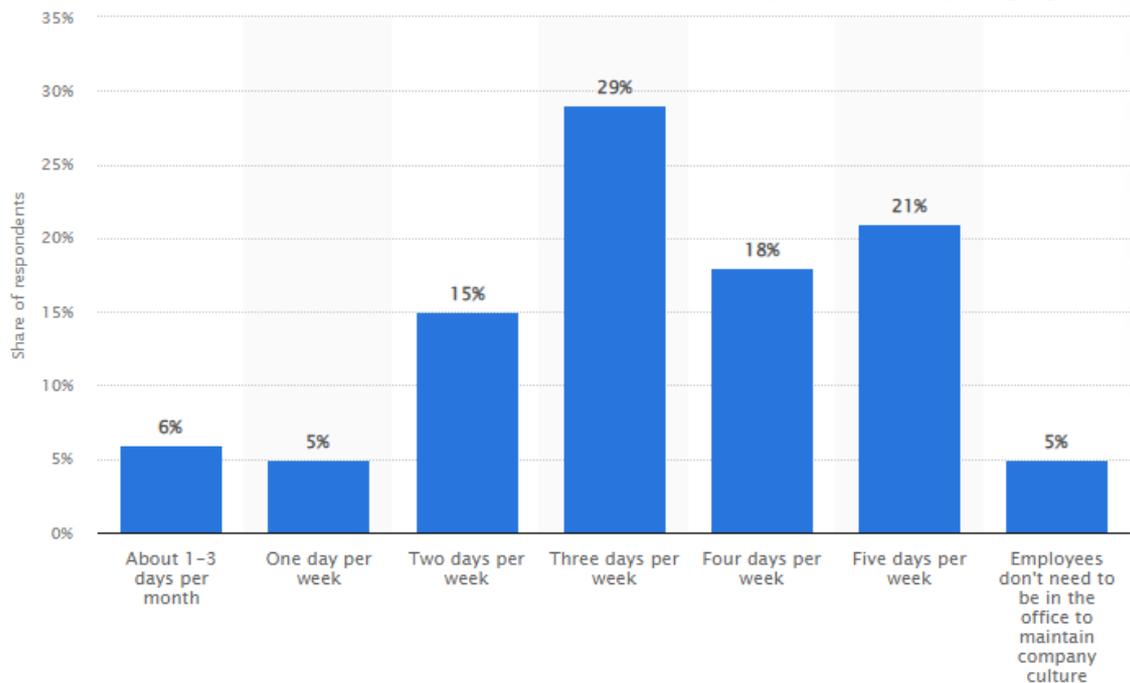


Fig. 3. Executives' opinion on remote work and company culture in the United States 2020 [12]

Statista 2021, PwC (PricewaterhouseCoopers) [13], performed a survey as indicated by a new overview, 29% of respondents from the United States express that worker ought to be in the workplace for three days per week to have a solid organizational culture since it alludes to a bunch of shared qualities, perspectives, feelings, objectives that portrayed in an association. Because of the distant working framework, the representatives have the expansion in various areas yet there is an absence of organizational culture [13].

6. Future of Remote Work Process

Considering the present second wave pandemic situation it is highly impossible to do onsite work. Simultaneously, there are vaccination doses all around the globe and it is a happening aspect

wherein future there might be the onsite and offsite working system which means the hybrid mix of the remote working system may implement [14].

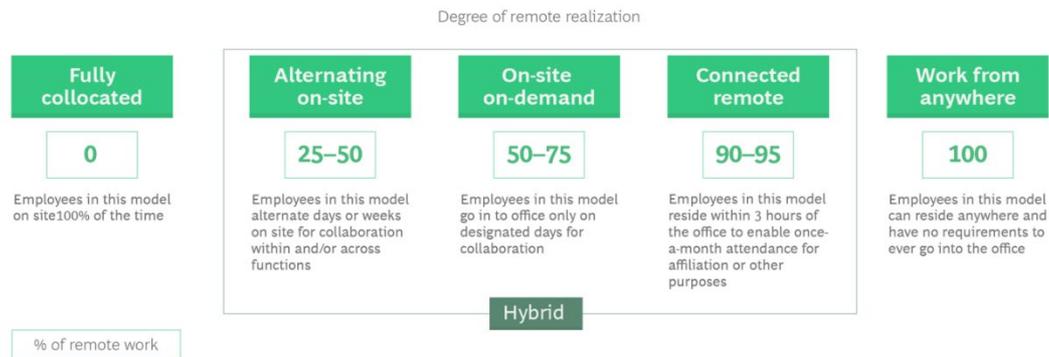


Fig. 4. Multiple Hybrid Models for the Workplace of the Future [13]

Fig. 4 depicts how the remote working system with the hybrid mix models and the workflow is shown. The employees in this model are doing their work onsite and in alternate days or weeks remote work for coordination within the organization functions which leads to both ends satisfaction, fulfillment for workers and organization holders. Employees also can have a healthy atmosphere onsite and in offsite remote work which will balance all aspects and can work efficiently to produce good productivity. With this pre-vaccination for Corona Virus, in the future the organizations will adopt the hybrid mix model of the remote working system will lead to a flexible and scalable working system all around the globe for the development of their company [15].

7. Conclusion

COVID-19 has brought a massive drastic change all over the globe. It is very strenuous to have a traditional workflow in such a condition for any organization. Considering these pandemic situations many firms converted their workspace to a remote working system. All the above survey reports state that so far, the remote working system is giving good productivity and the organizations are satisfied with the employees. But to maintain a healthy environment one should maintain their company culture with is lacking due to the current pandemic. Digital communication tools make an appearance as workable and modifying tactical tools, which allows quick updating of business strategy and offers protection from disruptions of external disturbance like a corona [16].

Considering the COVID-19 circumstances there might be an increase of this disease in the future, but foreseeing the future challenges, organizations should re-think their digitalization strategy by exploiting the opportunities of digital technologies. Unquestionably, in the future, it is very important to take the challenges experienced by the employees seriously as the current telework trend is likely to continue and become a common way of working in the future.

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ENVIRONMENTAL CONDITIONS AFFECTING THE SUSTAINABILITY OF OPEN METALLIC STRUCTURES

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Abstract: *The degradation processes that metallic structures suffer during their useful life significantly affects their durability, stability, and environmental impact. This degradation is mainly due to both a physical and a chemical mechanism. The main cause that triggers both phenomena is atmospheric pollution. Managing this complex multifactorial phenomenon ultimately reduces materials and maintenance needs, which is essential for the development of a sustainable society. The aim of this research is to study the environmental conditions affecting the degradation properties of metal structures exposed to weathering. After literature review, regarding abrasion, location seems crucial, while regarding marine corrosion, chlorides deposition main influencing factors vary greatly. Improved knowledge about the degradation of these materials will lead to a significant increase on products quality to successfully meet today's sustainability expectations.*

Keywords: environmental degradation, weathering, sustainability, metallic structures

1. Introduction

The degradation processes that open structures suffer is one of the most demanding challenges the industry is facing [1]. Poor durability of many structures around the world results in a short service life, high maintenance investments and heavy impacts on the environment, which is in no way sustainable.

Structures that are subjected to atmospheric conditions degrade mainly by two mechanisms: a physical one, by direct impact of particles on the surface [2], and a chemical one, by the formation of galvanic cells [1]. The main cause that triggers both phenomena is atmospheric pollution [3].

Atmospheric pollution can be in the form of solids, gases and aerosols (small liquid droplets), the most common pollutants are sea salt (NaCl, MgCl₂), industrial or anthropogenic pollutants and particulate matter [4].

These phenomena have attracted increasing attention in recent decades due to the resulting catastrophic accidents [5] and the growing demand for sustainable designs [6]. Despite efforts to gain knowledge on atmospheric corrosion, investigation still needs to be done, especially regarding the effect of chloride deposition on corrosion rate.

By adopting different prevention strategies, it is possible to extend the service life of exposed structures, reducing the maintenance actions required throughout their operational phase and reducing their environmental impact. To do this, the first step is to have an in-depth knowledge of the factors that affect this phenomenon and thus be able to deal with it correctly. The whole process is shown on Fig. 1.

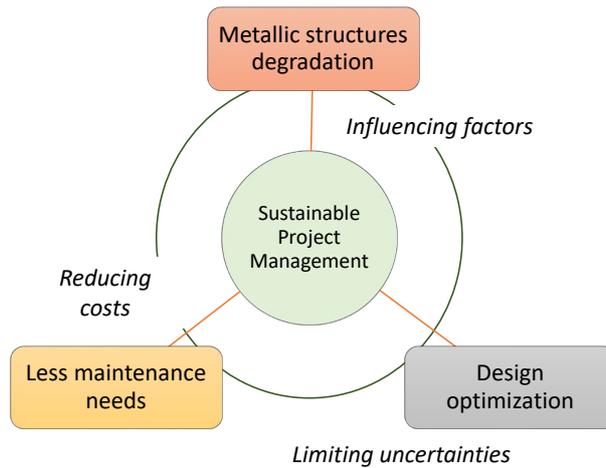


Fig. 1. Sustainable project engineering designing of metallic structures schema

2. Physical Degradation

Abrasion is the process of erosion caused by suspended particles impacting objects (Fig. 2). Depending on the type of carrier fluid, and the way in which the impacts occur, there will be different types of abrasion [1]. Wind erosion is more pronounced in dry regions and in areas where precipitation is not sufficient to support vegetation. Wind cannot transport particles as large as other fluids, such as flowing water, but easily picks up soil particles. The flow of sand transport can totally or partially damage the metal surface depending on wind velocity, angle of impact, the mechanical strength and the shape of the solid particles involved in the erosion process.

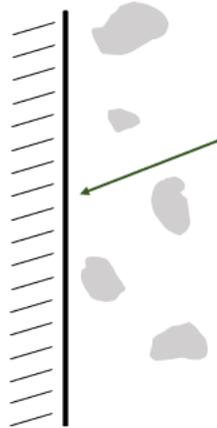


Fig. 2. General example of particles impacting a surface

There are many abrasion models focused on soil erosion that predict consequences on crops, conservation of natural resources or soil improvement [7] [8]. There are also computational models for erosion control by particles in pipelines, especially in the oil industry such as [9].

Unfortunately, all these findings are not directly applicable to abrasion caused by particles moved by wind, since, as introduced above, the fluid that transports it, in liquids, has a greater carrying capacity, allowing it to drag more and much larger particles.

Another way of approaching this problem is with a better protection of the material, which implies, therefore, studying coatings [10][11]. Clearly, the fields involved, and the related studies are very diverse.

From Inner Mongolia University of Technology, several researchers have focused on understanding this phenomenon and tried to model it in several of their studies [12], as the coating of steel structures in the central and western regions of Inner Mongolia has been severely eroded by these sandstorms. One of his objectives was to find a formula to model the results obtained in experimental tests [13] and then simulate it with finite element models [14]. The problem of generalisation of these studies is that they are focused on steels protected by paints, and the reality is that abrasion in such structures is much worse.

This problem is having an increasing impact. Friction and wear in the mining industry in milling, excavation, conveyors, pumps, dewatering and separation is estimated to be responsible for 50% of annual wear-related costs [15] and 2.7% of global CO2 emissions [16].

2.1 Influencing Factors

The most reliable option to know the actual sandstorm erosion hazard would be with actual outdoor exposures of certain materials. However, this can be a time-consuming task. There are more accessible parameters that can serve as indicators [17].

Potentially hazardous regions that may suffer from abrasion usually meet some of these criteria:

- Particles size distribution

Sand transport by wind is characterised by three modes of particle movement depending on the grain diameter [2]. Table 1 presents different ways of transporting sand particles.

TABLE I. Different Forms of Wind-Driven Movement of Sand [18]

	<i>Minimum diameter (mm)</i>	<i>Maximum diameter (mm)</i>
Long-term suspension	-	0.02
Short-term suspension	0.02	0.07
Saltation	0.07	0.5
Creep	0.5	-

Among all transport mechanisms, saltation contributes mainly to the total mass of sand moved [19].

- Location

Not all locations can suffer from this phenomenon, as it is specific from desertic and coastal zones. Areas prone to windblown sand occupy about one-fifteenth of the Earth's surface. These areas are increasingly growing their human activities, such as transport, industrial, mineral and residential activities [17]. In desert and coastal regions, more and more civil structures and infrastructure are being built [10].

- Meteorology

Climate conditions are of utmost importance. Wind speed usually need to be above 10 m/s, relative humidity (RH) needs to be low and, on the contrary, the concentration of total suspended particles high [17].

In this context, climate change has a strong impact on the ambient conditions (e.g.,[20]) and the frequency of occurrence of sandstorms has increased considerably [21]. Therefore, environmental measures need to be updated to properly design new structures and ensure the reliability of existing structures. Thus, another important feature is the relationship between high wind speed and low relative humidity [22].

- Geology

Those terrains with no surface characteristics, no vegetation nor obstacles acting as a barrier to the wind are susceptible places. Regarding their composition, low clay content in the soil, makes water absorption less efficient, reducing soil moisture, thus, and benefiting saltation [17]. When there is high quartz content in the soil, it can be more damaging. This is because quartz particles are harder than other kind of particles [2].

3. Chemical Degradation

Corrosion is the decomposition process of a material caused by a chemical reaction with its environment [23]. Corrosion of metals occurs when a surface encounters a gas or liquid, thus creating a corrosion cell (Fig. 3). The process is accelerated by exposure to hot temperatures, acids, and salts. In particular, the presence of chloride ions is the main cause of corrosion in structures in coastal regions [3] as it has an accelerating effect [24].

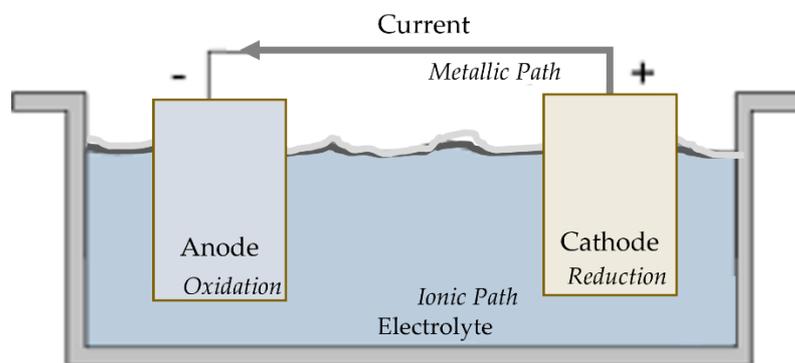


Fig. 3. Main parts forming a corrosion cell

Atmospheric corrosion is a complex electrochemical process involving many factors and variables. Depending on the composition of the atmosphere, it will be more or less aggressive towards the metal [25]. Once the contaminants present have been deposited on the metal surfaces for some time, other factors such as humidity and temperature play an important role too [26].

All these contaminants have some influence on the final corrosion rate but specifically, the presence of chloride ions has an accelerating effect [24], being precisely the main cause of degradation in coastal regions [3]. This is why coastal atmospheres with dissolved salt particles in the air considerably increase corrosivity levels [5][3]. Different studies [24][27] show that from a chloride threshold value of about 20 (mg Cl-/m²-day), the increase in the corrosion value is very significant. Similarly, it is also important to note that for values above 600 mg Cl-/m²-day, the corrosion rate seems to stabilise [28].

Aerosols containing chloride ions are mainly generated during the interaction between wind and waves [29], these particles are then transported by wind and clouds and deposited on structures. [30]. The role of chloride ions in the atmospheric degradation process is extremely complicated.

3.1 Influencing Factors

It is clear that in coastal regions, the corrosion rate decreases with increasing distance from the coast [31]. Nevertheless, relating it exclusively to the distance to the ocean does not reflect the efficiency of chloride transport [32]. Due to the complexity of the process, there are numerous variables involved. From the literature and the different studies [3], the most important variables are:

- Distance to coast

Previous research has shown that the chloride content of the air decreases with increasing distance from the coast [33][34][35]. This effect is not linear and weakens at greater distances (Fig. 4, data extracted from [36]), where large particles are less numerous, due to the gravimetric effect.

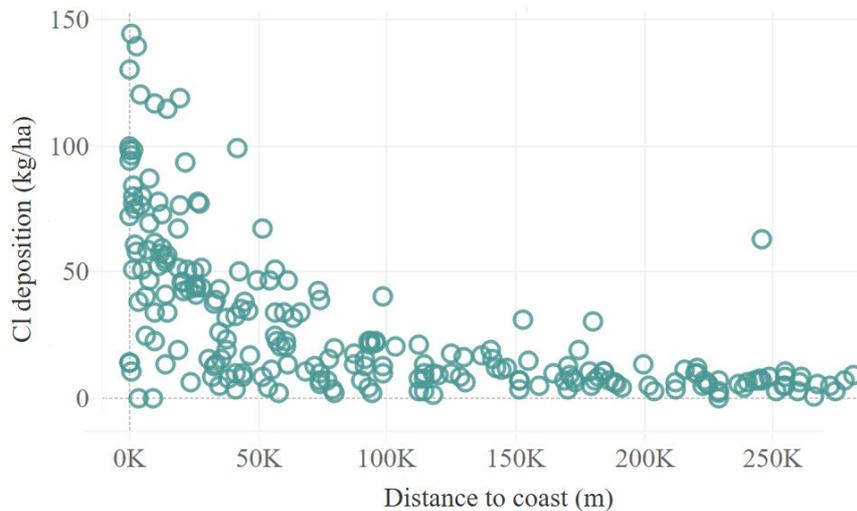


Fig. 4. Results of chloride deposition along distances from the sea

- Waves

Wave height [28], seasonal changes in the shoreline or bathymetry influence the amount and size of aerosols present on the coastline [26]. Away from the coastline, wind over the oceans creates aerosols through direct tearing of wave crests, typically at wind speeds exceeding 7m/s [37].

- Salinity

The salinity of the oceans ranges from 31-39 g/L [38]. The amount of salt present is categorised according to Practical Salinity Units (psu). There are certain areas with a higher amount of salt per litre of water, which will therefore be susceptible to higher deposition concentrations.

- Elevation

Elevation is a complex parameter. Wind speed increases with increasing altitude, resulting in higher amounts of sea salts in air aerosols and higher deposition of chlorides. [3]. On the other hand, larger marine aerosol particles tend to descend due to the gravitational effect [39], which conversely results in the low amount of atmospheric chloride at high altitudes [39].

- Orientation

The orientation of the structure, although less studied, has sometimes been treated in conjunction with the degree of coverage. Liu et al. categorised the structures in their study into two, whether they were facing the sea or not [40], being much more prone to higher deposition of chloride ions.

- Precipitations and temperature

Atmospheric conditions are all influential, and most of them have been studied both individually and together. This research [40] shows, among other things, that large variations in temperature and rainfall facilitate chloride deposition. It is therefore important to take into account significant variations in these variables at the site of interest. Moreover, as they conclude in [41] there is a higher rate of chloride deposition during periods of the year with lower rainfall and higher temperatures (dry seasons) than during wet seasons.

- Relative humidity

The relative humidity of the environment affects the moisture level of the surfaces themselves, which can contribute to the process of deposition and retention of contaminants in certain structures [26]. The influence of relative humidity on salt concentrations is particularly important between 50% and 70%, due to salt wetting. This, increases particle size [42] making it difficult to transport.

- Wind speed

Wind undoubtedly plays a key role and has a clear importance in the transport of marine aerosols [3]. Besides, marine aerosol generation is strongly influenced by wind characteristics [42]. Strong winds allow larger aerosol particles to travel greater distances before being deposited and also increase the concentration of salts in the aerosol itself [43]. Thus, at the same distance from the ocean, higher chloride concentrations are observed with increasing wind speed; Several studies conclude that this relationship is exponential [44] [45].

Some authors agree that the influence becomes clearer above a certain threshold, but there is no single reference value (3 - 7 m/s) [43]. In addition to wind speed, residence time and wind direction are also important. Analysing the prevailing winds at a given location can help to identify more dangerous areas. On the other hand, Feliu et al. [46] presented in their findings that wind energy (wind speed multiplied by residence time) is more related to deposition rate than just wind speed alone.

4. Conclusions

Atmospheric corrosion has serious economic and environmental consequences through the degradation of structures. There are numerous variables involved in both processes and their complexity means that they are still unknown phenomena. Few researchers have carried out empirical studies in different parts of the world, most of which have come to conclusions on the characterisation of the local atmosphere, which complicates the generalisation of ideas.

Physical degradation caused by the abrasion of windblown particles is a phenomenon typical of certain dry places with large amounts of sand and high wind speeds.

The chemical composition of the soil also plays an important role in terms of the hardness of the sand.

Regarding chemical degradation, the main pollutant is wind-blown marine aerosols containing chloride ions from the ocean that are then deposited on the structures.

The role of two crucial variables is highlighted: the distance to the emitting source of the pollutant particles (generally the ocean) and the speed and direction of the prevailing wind.

Considering the most important studies, the most influential variables in both phenomena were summarized. It is concluded that more research is needed in this sector, especially regarding potential locations and interactions between variables. The proper management and understanding of this problem will greatly improve the durability of materials and thus, less maintenance operations will be required.

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HOW COULD ORGANIZATIONS HELP THEIR EMPLOYEES BUILD SENSE OF COHERENCE DURING COVID-19 OUTBREAK?

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Abstract: *Stress, anxiety and uncertainty associated with the COVID-19 outbreak have introduced risks to the psychological and mental health of employees. Organizational reactions and practices have varied greatly in how they address employee concerns and stress caused by the pandemic. This study employed the sense of coherence (SoC) construct as a framework to explore the practices employed by organizations that help employees to cope with stress-producing experiences in the pandemic. Findings from interviews with 12 employees have revealed five themes that promoted SoC through building comprehensibility, manageability, and meaningfulness of work-related factors and helped employees to better handle the most stressful experiences created by the pandemic.*

Keywords: COVID-19, sense of coherence, health and well-being of employees

1. Introduction

COVID-19 has not only caused physical health concerns but also resulted in severe mental and psychological health problems for all individuals across the world [1], [2]. Social isolation and loneliness due to quarantine, threat of being infected or infecting family members, fear of losing job and distress of financial hardships are among some of the causes of elevated stress, concern, and anxiety [3], [4].

The Pandemic has brought increased stress and tension into the lives of many employees for different reasons. Faced with the enforced remote working conditions [5], employees have experienced reduced productivity [6], work-family conflict [7], decreased motivation and lack of social support [8], all of which have led to reduced well-being and poor psychological health [9]. Given this variety of distressing experiences caused by the pandemic, it is important to understand how employees could deal with stress and, at the same time, keep functioning and performing successfully.

Research has demonstrated that job-related stressors, demands and challenges during the pandemic are different from those of pre-pandemic times [10]. That is why resources and supporting mechanisms that best meet the needs of employees and promote their health and well-being might be unique to these unusual times [11]. Hence, organizations are called for taking necessary actions to mitigate the adverse impacts that COVID-19 may have on the well-being of employees [12].

One important personal resource that might help employees to deal with the stress and maintain mental and psychological health in the face of difficulties associated with the pandemic might be sense of coherence (SoC). SoC represents the extent to which individuals have the internal resources to adaptively cope with difficulties and uncertainties [13] and perceive that they have control over life events [14]. Prior research has revealed that SoC is an effective personal resource that increases employees' endurance and perseverance during challenges and stressful situations in life and work context and it might be promoted by organizational and work-related factors. In

the present study, organizational practices that might strengthen employee SoC during the pandemic are explored.

2. Sense of Coherence

SoC construct has originated from Antonovsky's theory of salutogenesis [15]. He studied survivors of concentration camps to find out that not all survivors were affected in the same way. Some have managed to stay healthier than others, although they all faced similar threats and difficulties. He proposed the SoC construct to explicate how some people better manage difficulties and stay healthy in the face of severe and stressful conditions. Accordingly, people who perceive their environment and the events in their lives as comprehensible, manageable, and meaningful could better cope with stress and uncertainty [15]. The Comprehensibility dimension of SoC indicates the degree to which a person has a sense of control over events and perceives the environment as structured, predictable and explicable. The Manageability dimension refers to the self-confidence that the person has the resources required to successfully meet the demands. The last dimension, meaningfulness, alludes to a motivation to persevere as demands are perceived as challenges worthy of investment [15].

Prior research has demonstrated the positive role of SoC in predicting good health and well-being. For example, high levels of SoC were found to buffer negative impacts of stressful experiences and improve the immune system [16] and decrease mortality [17]. In the work context, high levels of SoC were found to decrease sickness absences [18], [19], protect the psychological health of employees against the adverse effects of organizational merger [20], lower employee stress and depression [21], decrease the adverse effect of job demands on burnout [22], [23] and improve general and occupational well-being of employees [24].

Given the positive outcomes of SoC in increasing resistance and endurance in the face of stress and maintaining psychological and mental health, it is important to understand what factors and resources help employees to build higher levels of SoC. Antonovsky [25] suggested that organizational context and work environment could influence employees' SoC. Empirical studies have supported this suggestion by showing that low job insecurity, good organizational climate [24], employee involvement practices [21], positive psychosocial work environment characterized by flexibility, autonomy, and social support [26], and job resources such as job control, role clarity and social support [27] enhance employees' sense of comprehensibility, manageability, and meaningfulness of organizational environment.

Drawing on these studies on the positive effect of organizational factors strengthening employees' SoC, this study aims at exploring the practices conducted by organizations during the COVID-19 outbreak that have promoted higher levels of SoC and helped employees cope with uncertainty, difficulties and stress associated with working in such a demanding and challenging situation. Given that COVID-19 has changed the way people work (e.g., remote working) and deprived employees of the resources that they had access to in pre-pandemic times, organizations might attempt to provide additional resources that might strengthen the SoC of employees and help them gain much control when dealing with the adverse effects of the pandemic and the stress it has created.

3. Methodology

In order to understand practices conducted by organizations that might act as resources strengthening employees' sense of comprehensibility, manageability and meaningfulness of the work and organizational environment during the pandemic, unstructured online interviews were conducted in October 2020. Using convenience sampling, 12 white-collar employees (9 females, 6 supervisors) working in Turkey were contacted. All employees have begun to work remotely

right after the first cases in Turkey were announced. Participants were asked to evaluate the efforts, performance and attempts of their organizations regarding supporting, encouraging, and maintaining employee well-being. Responses were analyzed based on theoretical thematic analysis [28]. Responses were assessed based on three theoretical dimensions of SoC (comprehensibility, manageability, and meaningfulness) and coded accordingly.

4. Results and Conclusion

Thematic analysis emerged five different themes which are protecting the health and safety of organizational members, communication of upper management, providing social support to organizational members, supporting employee growth and development, maintaining financial support and benefits, exhibiting tolerance and flexibility.

The first and the strongest theme that appeared in the responses was organizations' efforts to maintain and protect the physical health and safety of all employees. Participants appreciated organizations for showing genuine care and concern about the physical health and well-being of the work force, taking a wide range of precautionary measures for those having to work on-site, putting remote working plans into action very fast to keep everyone safe and constantly monitoring the health of the work force through regular communication. Given that the threat of being infected or infected loved ones is among the most important stressors during the pandemic [3], organizational efforts to ensure employee health seem to help employees to develop a sense of comprehensibility and have a feeling that potential threats to their health are under control. Participants stated that organizations' giving close attention to employee health mitigated the disproportionate health concerns and helped perceive themselves as secured and more valued by their organizations.

The second theme was the communication of the upper management. Participants expressed their concerns about job security considering the economic consequences of the pandemic. Such concerns cast doubts on their future employment in the organization and posed a threat to their sense of comprehensibility. Hence, when representatives of top management informed organizational members about the organization's current financial situation, future estimations and actions, whether any employment was planned, employees experienced less ambiguity and uncertainty and thus had a clearer perception about their employment situation.

The third category of organizational practices that helped employees build SoC was found to be providing social support. One of the challenges of the extended lockdown and quarantine periods was the feelings of isolation and loneliness. Participants expressed that having a remote working plan, they lacked the social connection they once had when they worked in offices. This aspect relates to the meaningfulness dimension of SoC. Participants expressed their appreciation for organizational efforts to organize online social gatherings and meetings, virtual club initiatives and stated that they felt less anxious and more motivated thanks to these organizational efforts.

The fourth category was found as supporting employee growth and development. Along with social support, some organizations have attempted to provide their employees with more opportunities for self-growth and development by organizing online courses or offering financial aid for e-learning. The adverse effect of the pandemic on economies has resulted in financial uncertainty for employees regarding their future employment. Yet, enhancing their qualities thanks to this organizational support on e-learning on several aspects induced employees with both a sense of comprehensibility and manageability. Having higher competence helped employees to see their future employment opportunities as more predictable and also increased their self-confidence that they are qualified enough to meet the demands of the marketplace.

The fifth theme was found to be maintaining financial support and benefits. Participants expressed that they really appreciated organizational attempts that provide them with financial aid or

maintain existing financial benefits despite potential financial problems such as decline in sales. On the other hand, some other organizations cut down some benefits such as meal tickets on the grounds that employees shifted to a remote working plan or fell short of providing necessary set-up required for effective functioning, such as internet or call packages. Presence and absence of such financial resources relates to the manageability dimension of SoC. When employees are assured that they have the means required for better performance, they can confidently concentrate on their obligations and duties. On the contrary, the absence of such resources might induce a perception that employees are not equipped enough to deal with job requirements and thus impair SoC.

Overall, the findings of this study support Antonovsky's [25] argument that well-resourced organizational environments equip employees with the self-confidence that they are able to predict, manage and invest in the existing challenges associated with their working life. This is also consistent with previous studies suggesting that SoC could be promoted through adequate organizational and job-related resources [24], [27]. Drawing on the findings of the present study, organizations are recommended to strengthen their employees' ability to cope with distressing working conditions of the pandemic through caring for the psychological health of employees, informing employees on a regular basis about current and future plans, operations, actions and decisions of the organization, providing social and psychological support, supporting employee growth and development, and supporting employees financially.

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EFFECTS OF TECHNICAL RISK ON THE PERFORMANCE OF CONSTRUCTION PROJECTS

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Abstract: *The construction industry is commonly known as a project-based industry due to its nature. On the other way, the construction project is very complex and ambiguous and faced a lot of challenges and risks for getting success or for performing well. There are many risk factors are identified so far and categorized under the head of the internal, external, and project risk which cause the project performance. This research study discussed the technical risk factors identified so far and find out their impact on project performance. The research was organized in the United Kingdom. A self-administrated questionnaire was used for data collection; data was collected from 37 project managers from construction companies of the United Kingdom. For data analysis, Statistical Package for the Social Sciences (SPSS) is used. The result stated that technical risks factors have a strong negative impact on the project performance.*

Keywords: project risk, technical risk, project performance

1. Introduction

Project risk management is considered an integral part of the project management process but also it prevents the project from failure [1]. Every risk factor has hidden some positive attributes in it, but when organizations try to manage risk, they only focus on its negative aspects [2]. In previous research, the researchers mainly focus on figuring out the impact of risks on some phases of project plans such as time, cost, and safety [3]. [4] identified the subsequent risks such as technical risk, market risk, nature risk, time-related risk, financial risk, external risk, and risk related to human factors and workplace safety. All these above-mentioned risks have several factors, but this research mainly focuses on the identification of the technical risk factors and figure out their impact on the project performance. No prior study has been done so far which testify this hypothesis on the construction projects of the UK. So, the aim of this research is to answer the question of Is there any effect of technical risk factors on the performance of construction projects?

2. Literature Review

Current literature presented that there are many deficiencies in the risk management process in construction projects which need to be addressed because this industry faced a lot of uncertainties, diverse risk, and complexities. The risk management process has been defined as the identification and measurement of risks and introduced methods and techniques which help to reduce those risks at an acceptable level [5]. Project risk management system helps in identifying, monitoring, or controlling the risks which arises for the project success [6]. Other than industrial projects, a percentage of canceled and challenging construction projects are at their peak in the UK [7]. [8] stated that organizational support to the risk management process is considered as the backbone for the success of any business. [7] emphasized that a risk management system is one of the key areas, and its methods and techniques are needed to complete any project. The construction industry is considered the largest sector in the UK economy, it has seven percent shares in the gross domestic product or contributes ten percent in the total employment [9].

H₁: There is a negative relationship between technical risk and project performance

The most common risk factors that come under the heading of technical risk are associated with incomplete design, scope changes, limited resource availability, changes in design, inadequate specifications, and construction procedures [10]. Technical risks can also be defined in way of unusual design changes, or errors in custom design and practices which may delay the project or increase its cost [11]. Each organization wants to fulfill its projects according to given conditions and makes them successful because it's vital for survival or to remain in the market with a good reputation [12]. In construction, the most used performance measures are considered those which can be measured physically. The most used performance measures in the construction industry are considered those which can be measured physically [13]. In construction projects, the most used statistics are time, cost, quality, defects, and productivity [14]. [15] affirmed that the key performance indicators (KPI) were established to gain access to the performance of a project or organization in the construction industry.

3. Research Methodology

This research study was positivist in nature and used a deductive research approach also its cross-sectional. The construction industry of the United Kingdom was taken as the population for this research. All countries of the United Kingdom were included in the population. 92 project managers from the construction sector were an appropriate sample size for this study. A total of 92 self-administrated questionnaires were floated, but only 37 useful questionnaires were backed and considered for final evaluation. So, the response rate was 40%. A web-based survey method is used, and a questionnaire was sent to the project managers through email. In the research, the unit of analysis was the project managers of the construction companies of the United Kingdom. A questionnaire was consisting of two parts: the first part was based on the demographics of respondents such as (Gender, Qualification, Designation, Region, and Industry Experience), these items were measured on a nominal scale. In the second part, questions were based on technical risk factors (12 Items) and project performance (3 Items).

4. Data Analysis

Data analysis has been done through Statistical Package for the Social Sciences (SPSS). To measure the reliability of the instrument, a reliability test has been performed. The accepted value of the reliability test is 0.7 so, both variable's reliability values were up to the mark (technical risk, 0.886; project performance 0.904). Pearson correlation analysis has been performed, and its value ($r = -.590$) depicts a strong negative relationship between technical risk factors and project performance. The model showed the value of adjusted R² and R² was (0.330 and 0.348 respectively) which means linear regression explained only 33% of the variance in the data and still, 67% variance is unexplained, which depends on the factors not included in the study. The value of Durbin-Watson was ($d = 2.090$) which showed, not first-order linear autocorrelation in the data. F-test depicted the significance value 0.000 which is acceptable and below the given range of 0.05. Unstandardized beta coefficients value depicts the change that comes in the dependent variable due to the independent variable. In the study, the beta value was -0.514 which indicates that if there will be a unit change in technical risk factors it will result in a -.514 decrease in project performance by holding all other variables constant. The findings depict no multicollinearity in the data.

5. Conclusion

In the current era, the construction industry is growing rapidly in the world, both developed or developing countries investing in construction projects. But along that industry also incorporates many issues and complexities such as cost overruns, weather conditions, political instability,

technical uncertainty, and newness of the technology. There are many other factors too, which make the project risky and complex, this will affect the performance of projects and make them unsuccessful. This research identified the more impacting technical risk factors which cause poor project performance. There are many other risk types such as legal, political, financial, environmental risk not included in the study. In future research, it can explore these types and their impact on project performance along with a large sample size and get more precise results.

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EXPLORING PREDICTIVE ANALYTICS FOR STOCK PRICES: LOOKING TOWARDS PRESCRIPTIVE ANALYTICS

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Abstract: *Though the Analytics techniques have consolidated in the Descriptive and Predictive approaches but the field of the Prescriptive Analytics approach is yet a work in progress. Many researchers have proposed the prescriptive analytics approach to integrate appropriate optimization techniques along with traditional predictive approaches. The interconnection between predictive and prescriptive techniques is explored widely thus in our proposed work, it is endeavored to explore the forecasting of stock prices which plays a vital role in today's businesses and economics. The advent of enhanced computing resources and various machine learning models, facilitates investors and researchers to keep track of stock prices daily. Several machine learning models, like neural nets, and genetic algorithms have already been developed to predict stock prices. In this piece of research work, we have tried to apply the Optimization technique to popular existing machine learning models to improve the predictions to facilitate the trader's optimal stock prices. Furthermore, proposed model adopts the FMINCON optimization technique, (Finding Minimum Constraints) on the ARIMA model and compares the resulting prediction of stock prices with the Long Short Term Memory(LSTM) deep learning model. The results are shown with the comparative analysis with deep learning and statistical methods like ARIMA.*

Keywords: Stock Prediction, Prescriptive Analytics, Long Short Term Memory (LSTM), Auto-Regressive Integrated Moving Average (ARIMA), Optimization, FMINCON (Finding Minimum Constraints)

1. Introduction

In today's data-rich world, Business Analytics has become quintessential for any organization. The Analytics approaches though have been handling different sets of questions through their approaches; For example, the techniques with the Descriptive Analytics approach would by and large handle the questions "What has happened" with a possibility to explore that further "Why did it happen" thus moving towards causal structures while the Predictive Approaches answering the questions "What will happen in future" with a possible exploration towards "Why will it happen". However, it was realized that the organizations would be much more benefitted when rather than "Why" it had happened and "What" will happen, can be augmented with "How can I make it happen in the future", thus positioning it to set specific business targets and devise strategies to achieve it with a data-driven approach.

Some researchers have presented their vision of Prescriptive Analytics highlighting the application domains of Logistics and oil believing that leading IT companies like Google, Facebook, Amazon, etc may deliver Prescriptive algorithms 'as a service' soon [13]. This direction has been towards predicting stock market prices while incorporating appropriate optimization techniques with predictive techniques.

The stock market consists of many investors and traders who are interested in purchasing and selling stocks according to the high or low prices. Stock is the monetary unit representing the

involvement of individuals, i.e., businessmen, companies, or corporations, and their claim to the assets and profits. [9] A financial gain happens once you sell a stock at a better worth than your bought. In the world of Economics share prices consist of the following key performance indicators (KPI):

- Opening Stock Price(open)
- Closing Stock Price(close)
- Low Price of the day(Low)
- Peak Price of the day(High)
- Total amount of stock traded in one day(Volume)

Many complex financial indicators result in very high volatility rates in stock prices from day to day. The evolution of computing power, database technology, machine learning algorithms, and optimization techniques help predict the stock market index more accurately [4]. Many specialized machine learning techniques like neural networks, support vector machine, etc. are already established.

The paper aims to design of some efficient machine learning-based hybrid models that are more suitable and explore the better implementations for analysis in the field of financial markets and look into the domain of Prescriptive Analytics. The manuscript's organization is as follows: Section 1.1, 1.2 explains the statistical and deep learning method for the forecasting followed by section 1.3 which explains the optimization technique used in the proposed work. Further section 2 states the literature survey part, section 3 provides problem definition and section 4 is about the proposed methodology followed by section 5 that explains results and discussion. Finally, section 6 and 7 are about conclusion and future scope of the manuscript.

1.1 Auto-Regressive Integrated Moving Average (ARIMA)

Box and Jenkins introduced ARIMA in 1970 which is also referred to as Box Jenkins Methodology. [2] This Model is widely used for financial forecasting which shows an efficient ability to generate short-term predictions. It specifically combines two simple models, the Auto-Regressive model, and the Moving Average model. It provides information about a given time series based on its own historical values, i.e, its lags and lagged forecasted errors. [1] It is a regression model whose features are estimated by the following parameters.

- **b**: Number of historical previous data to be considered for estimating the present data.
- **d**: Number of differences to have time series stationary.
- **q**: is the order of the Moving (MA) term

ARIMA consists of AR, I, and MA. Let's break down each term.

Auto Regression(AR): A regression model that inculcates dependency between lags and lags observations (p). [1]

$$X_t = \alpha + \beta_1 X_{t-1} + \beta_2 X_{t-2} + \dots + \beta_p X_{t-p} + \epsilon_t \quad (1)$$

where X_t is stationary variable, α is a constant, β is coefficients during lags and ϵ is residual.

I stand for Integrated which measures our observations' differences and helps in make times series stationary(d).

Moving Average (MA) is a method considering the relation among observations and lagged forecast errors.

$$X_t = \alpha + \epsilon_t + \phi_1 \epsilon_{t-1} + \phi_2 \epsilon_{t-2} + \dots + \phi_q \epsilon_{t-q} \quad (2)$$

where X_t is stationary variable, α is an expectation of X_t , ϕ are weights applied to the current and previous values of a stochastic term in time series and ϵ is white noise.

In an ARIMA model, the time series was differenced at least once to make it stationary. Now,

$$X_t = \alpha + \sum_{i=1}^p \beta_i X_{t-i} + \epsilon_t + \sum_{i=0}^q \phi_i \epsilon_{t-i} \quad (3)$$

on combining these two models we form an ARIMA model equation as following:

In simple words, it adds the constant and the Linear Combination Lags of X to the Linear Combination of Lagged forecast errors.

1.2 Long Short Term Memory (LSTM)

This model consists of memory cells, a unit of the artificial Neuron present in the network's hidden layer. It was introduced by Hochreiter and Schmidhuber in 1997 and is now tremendously used in various problems. The reason for the LSTM to be discovered is to solve the problem of long term dependencies. [6] Recurrent Neural Network (RNN) saves nearby inputs as activations. This is called short-term memory used in applications like speech processing, text generation and music composition.

Theoretically, Classic RNN keeps a record of long-term dependencies of input sequences. The disadvantages of these Classic RNN is that while we train the classic RNN with the help of back propagation, the gradients start to vanish (i.e. they move to zero) or explode (i.e. they move to infinity), because of the complicated computations. So, RNN is only useful to keep track of immediate recent data to do the current task. In such cases, where the gap between the useful information and the current task is small, RNN will work fine. But the case where the gap between the useful information and the current task is large, RNN becomes obsolete and might suffer from vanishing and exploding gradient. Thus the LSTM comes into picture which solves the problem of vanishing gradients.

The Architecture of LSTM usually comprises of a cell and 3 gates for smooth information flow in LSTM cells that is input, output and forget gate.

- Input gate keeps track of duration of flow of the new value in cell.
- Forget gate keeps track of duration of value to be existed in current cell.
- Output gate keeps track of what value should be used to compute output LSTM activation.

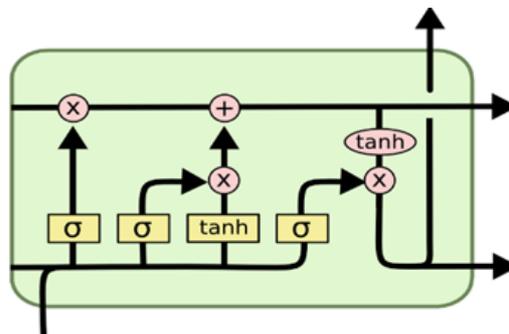


Fig. 1. The LSTM Cell

1.3 Optimization

Optimization in predictive analytics allows organization to solve complex business problems to achieve maximum results with minimal resources under real world constraints. It helps to find the best solution from a set of feasible solutions using mathematical algorithms that maximizes or minimizes our specified objective function subjected to constraints.

Machine learning predictions can be used to determine the need to make mathematical optimization decisions. Those predictions can be used as a variable in mathematical optimization decision constraints. [3] Mathematical Optimization decisions, in turn, can be used as feature in machine learning and can be used as machine model scoring/comparing input.

The optimization includes solvers for Linear Programming(LP), Quadratic Programming(QP), Nonlinear Programming(NLP), Nonlinear Least squares, Mixed Integer Linear Programming(MILP) and Non Linear equations. Different types of Optimizations can be used to find the best solutions in application such as Food and Beverage Industry, portfolio optimization, Airline Industry, Stock Market, etc. [3]

The Main Components of an optimization problem are as follows:

- **Objective Function:** It is a function expression with one or more quantities that is required to be either minimized or maximized subjected to constraints. The number of objective function may vary in optimization problem considering that the objective function is compatible.
- **Variables:** The unknown variables are used for defining the objective function and its underlying constraints. The variables chosen should be able to meet the certain specified functional requirements. They may be Boolean, continuous or discrete.
- **Constraints:** Set of certain constraints allows the unknowns to take specific values and not include others. These condition need to be satisfied to follow the objective function.

The classification of an optimization problem is based on types of the constraints, variables, and objective functions, and equations. The optimization problem can be based on constraints i.e Constrained optimization containing one or more constraints and Unconstrained optimizations. Also based on the equations, the optimization problem can be divided into Linear, Quadratic and Nonlinear programming problems.

- **Linear Programming Problem** is when the objective function and underlying equality and non-equality constraints are Linear;
- **Quadratic Programming Problem** is when our objective function is quadratic, and the underlying constraints are linear.
- **Non-Linear Programming Problem** is when our objective function and underlying constraints are Non-Linear.

1.3.1 FMINCON Optimization Technique: FMINCON Optimization Technique is used to minimize several variables considering the underlying constraints of the problem. It maximizes the log likelihood function using FMINCON from Optimization Toolbox. FMINCON has many optimization options, such as choice of optimization algorithm and constraint violation tolerance. It is a Nonlinear programming solver that finds the minimum of a problem as stated in below relation:

$$\min_x f(x) \text{ subject to } \begin{cases} c(x) \leq 0 \\ ceq(x) = 0 \\ (A \cdot x) \leq b \\ Aeq \cdot x = beq \\ b \leq x \leq ub \end{cases} \quad (4)$$

FMINCON uses a Sequential Quadratic Programming Method (SQP) for medium-scale optimization problems. At each epoch, the Quadratic programming sub problem is solved. Function of SQP is to solve array optimization sub problems, which further optimize a quadratic objective subject to underlying linear constraints. For unconstrained problem, the method finalizes to Newton's method to find one point where the slope of the objective vanishes.

The ActiveSet is used to solve Quadratic programming sub problems and convert inequality constraints to equality constraints which eases the solve of the equality constrained optimization problems. The requirements for FMINCON are:

- The objective function has to be minimized and the underlying constraints have to be continuous.
- Getting the local minima as a result.
- The real values have to be returned by objective functions and constraints.

2. Literature Review

There always exists a loose connection between the Predictive and Prescriptive Analytic approaches. However, some researchers have taken different positions on how this could be structured. The Predictive analytics approaches seem to be more or less settled with issues such as Training and Testing phases. The emergence of powerful Deep Learning models is fast changing the scenario with efficient deliverables. The role of Machine learning in Predictive approaches is well established but the research work in Prescriptive Analytics is rather not confined to Machine Learning alone. Prescriptive exploration has begun to manifest more recently. It is unclear or at least not unanimously agreed on how to go from a good prediction to a good decision. [17]. Some researchers have suggested these approaches towards the Industry 4.0 scenario with prescriptive business processes. The proposed benefits can be maximized while minimizing the expected risk and loss they say. Some researchers have considered the optimal mitigating actions to provide recommendations about the optimal time for their implementation. The researchers' Dick den Hertog et al has proposed bridging the gap between Predictive and Prescriptive Analytics with two approaches. The proposal is that prescriptive analytics should start directly with general nonlinear and nonconvex optimization using the predictive models. [19] This study introduces and applies the FMINCON optimization technique to the ARIMA model. It compares the forecasted optimal prices to the predicted prices of the LSTM model. A general overview of share price forecasting models is presented.

Ariyo et al. suggest implementing the ARIMA model on time series data of the New York Stock Exchange (NYSE) & Nigeria Stock Exchange (NSE) stock price. The ARIMA model surely has the upper hand in short term predictions that may vary from 1 to 30 days and can withstand existing stock prediction techniques. [1] The LSTM Machine learning model is more accurate than the ARIMA model for predicting stock market prices. The results were compared with existing stock price predictions by Nivethitha et al. It is concluded in the paper that it is more effective than the previous models. [6] Murtaza R, et al. have worked on RNN and LSTM for predicting the stock market indices. The results here are shown and compared, on the basis of Number of Epochs and Root Mean Square error (RMSE), with the help of 250 to 500 epochs [7]. The ARIMA is vastly implemented model in analyzing time series data and for forecasting future stock prices. A new model has been proposed that reveals better efficiency of ARIMA & SVM model in predicting future stock price. The study was done by Ariyo et al. Menon V.K, et al. used National Stock Exchange (NSE) to analyze stocks using AR and ARMA linear regression models. The study of this paper shows that if a prediction rises the AR (Auto regression) values is more accurate or else need to depend on ARMA forecasted value if prediction is in the fall.

3. Problem Definition

With the advent of electronic trading, the stock market has become one of the way in which only a few financial professionals will offer significant benefits. However, the high volatility of the stock prices makes it hard to predict the fluctuations. There is still potential to develop novel frameworks or systems that can meet the increasing financial requirements.

This work uses the Optimization technique algorithm to improve the predictions to obtain the optimal decision on stock prices. The ARIMA model adopts the FMINCON optimization technique, (Finding Minimum Constraints) on its own model and compare the resulting prediction of stock prices with the predictions of the LSTM model.

4. Proposed Methodology

In this work, we have proposed to implement Autoregressive integrated moving average (ARIMA) model on the stock price data and used the FMINCON optimization to churn out the optimal result for novel proposed ARIMA model. These predictions are then compared with LSTM model graphically as well as numerically. Fig. 2 explains the flow chart of the proposed methodology.

4.1 Dataset

Dataset used here is historical Stock data that is gathered from Yahoo Finance, i.e., TCS BO (Tata Consultancy Services – Bombay). The data consists of open/close/high/low features. In our models, we will mainly select the Open Price of the stock data for our prediction.

4.1.1 Dataset for LSTM Model: Dataset here is split into two subsets: training and test datasets where 70% of each dataset was used for training and the remaining 30% of each dataset was used for testing the models. For Training the model, Data from 01 Jan 2019 to 31 Dec 2019 i.e. 12 months. After Training the data, the next one month’s dataset 01 Jan 2020 – 31 Jan 2020 is kept up for testing to get the predictions.

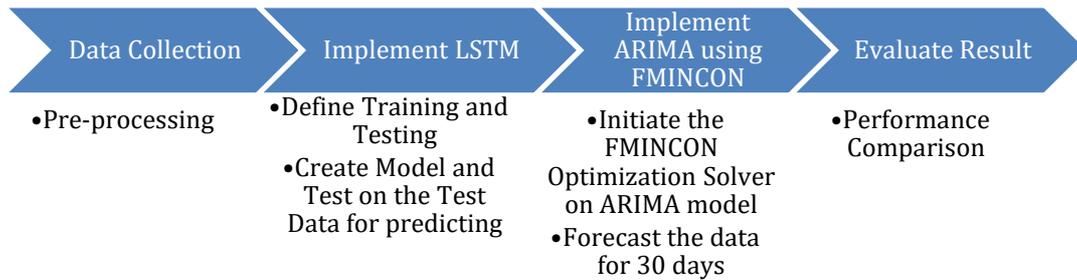


Fig. 2. Flow Chart of Implementation

4.1.2 Dataset for ARIMA Model using FMINCON optimization: We train ARIMA model train based on opening prices of the stock data. No Splitting has been taken place here as the stock prices needs to be forecasted in the ARIMA model. For Training the model, Data from 01 Jan 2019 to 31 Dec 2019 i.e. 12 months. After Training the data, like in the LSTM model we will not predict the data but we need to forecast the stock prices for next the month i.e. Jan 2020.

4.2 Implementing the LSTM Model

After collecting the historical stock data of TCS, the implementation consists of several steps which are as follows:

- **Data Preprocessing:** The preprocessing stage includes: Data reduction, Data Transformation (Normalization), Data Cleaning (Imputing the missing values) and Data Integration (Combining data files). Apply the Preprocessing technique using MinMaxScaler. This converts the input data in the particular range. That range varies from 0 – 1.
- **Training and Testing Data Split:** Data from 01 Jan 2019 to 31 Dec 2019 is used Training and 01 Jan 2020 – 31 Jan 2020 of one-month data is kept up for testing.
- **Feature Extraction:** Only those features are given to the neural networks which are important for implementation. In our case, Open price of the stock data is chosen for prediction purpose. [7]
- **Training Neural Network:** Sequential - LSTM based Recurrent Neural Network Type (of Deep Learning model) network is created. This network contains Convolution layer, Dense Layer, Drop Out Layer, Softmax Layer. The Train data from 01 Jan 2019 to 31 Dec 2019 is passed to the RNN, once the Network model is fitted trained for 100 epochs.
- **Testing the data:** After that Test data is called i.e. from 01 Jan 2020 – 31 Jan 2020. Like in Training data, we are taking the Open Price for testing purpose. Also, Apply pre-processing method to testing data. Then call the RNN network for the prediction by using the test data. [7]. Finally, we get the Predicted value, but we need to apply inverse transformed for the predicted value, then only we can get the exact result.
- **Plotting the graph:** Finally, Predicted Value is compared with Actual Data on Graphical Analysis with the help of Matplotlib. Also, Predicted Value is exported like EXCEL or CSV File to the Current working directory for future use.

4.3 Implementing Data Forecasting Based on Statistical Model i.e ARIMA with FMINCON Optimization Technique

After collecting the data for TCS BO, the ARIMA model needs to be implemented in MATLAB 2020. The following steps have been adopted for the efficient implementation as proposed:

- **Feature Extraction:** Extract the Open Price Data for Further use. Data from 01 Jan 2019 to 31 Dec 2019 for Training. Here also we select the open price for our prediction.
- **Creating the Model:** Create the ARIMA (Autoregressive integrated moving average) model for data forecasting.
- **Using the FMINCON Optimization Technique:** Initiate the solver to call the Optimization method on ARIMA Model. Here we are using the FMINCON – (Finding the Minimum Constraint with “SQP” algorithm and “ActiveSet”) Optimization process to forecast the optimal stock Price data. After that estimate the ARIMA model with Optimization Solver.
- **Forecasting the data:** Then we forecast the data like 30 / 60/ 90 /120 days. It will depend on user decision. But here in our previous LSTM Model our test data is for Jan 2020 month only. So to compare the results with an ARIMA model with LSTM model, we are also forecasting the data for Jan 2020 month itself.

5. Results and Discussion

Fig. 3 shows graphical representation in which the Predicted v/s Actual stock price data of Jan 2020 using LSTM model is plotted. Number of epochs used in this model is 100 and the batch size is 32. Fig. 4 shows the graphical representation of comparison Real TCS stock Price v/s LSTM Predicted stock price v/s forecasted stock price of ARIMA. Fig. 5 shows the graphical representation of Real TCS stock Price v/s LSTM Predicted stock price v/s forecasted stock price of ARIMA model using FMINCON optimization using ActiveSet algorithm is plotted.

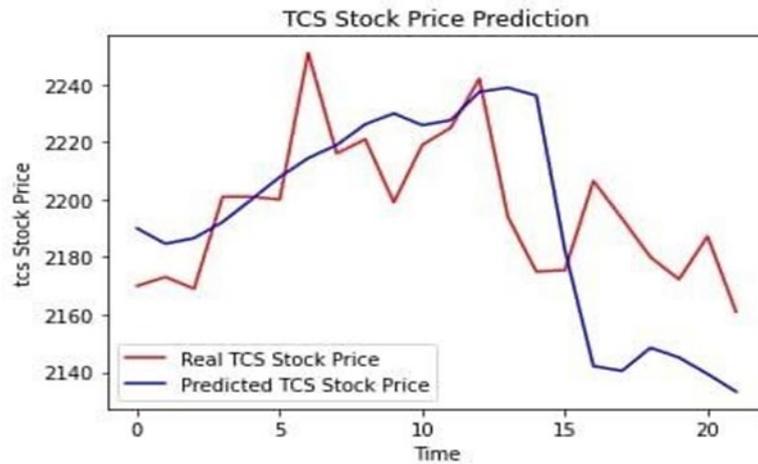


Fig. 3. Comparison of Real TCS stock Price vs LSTM Predicted stock price

Finally, the Predicted Values of all the implemented models is exported in the form of EXCEL or CSV File to the current working directory for future use by analysts. Table 6 shows all the predicted values and actual value for some days.

5.1 Discussion

According to the graphical representations of our implantation, we can infer the best optimal future stock prices. In LSTM with ADAM, due to iterative optimization algorithm, the results are obtained several times out of which the optimal one is selected resulting in minimized errors. Whereas in ARIMA model using FMINCON optimization the results are obtained better than the traditional ARIMA model. The Optimization used has done a great job in getting the better prediction results. It can be further enhanced by using the other Non-Constrained or constrained optimization techniques.

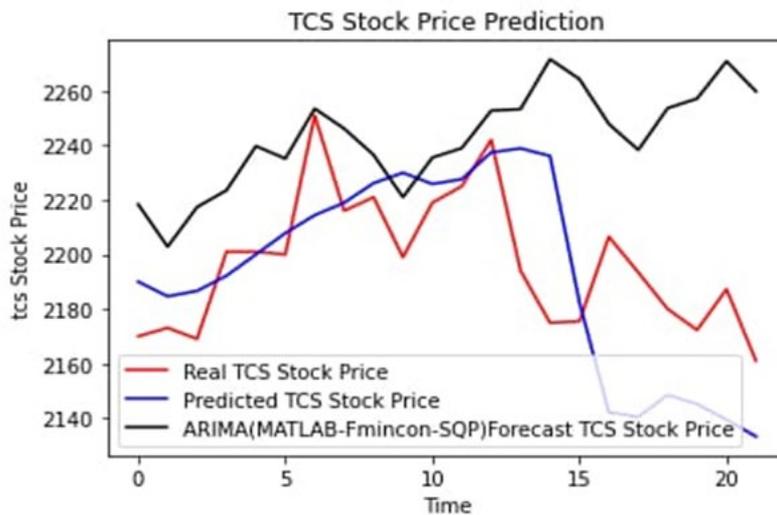


Fig. 4. Comparison of Real vs LSTM Predicted vs forecasted stock price of ARIMA model using FMINCON optimization using SQP algorithm model

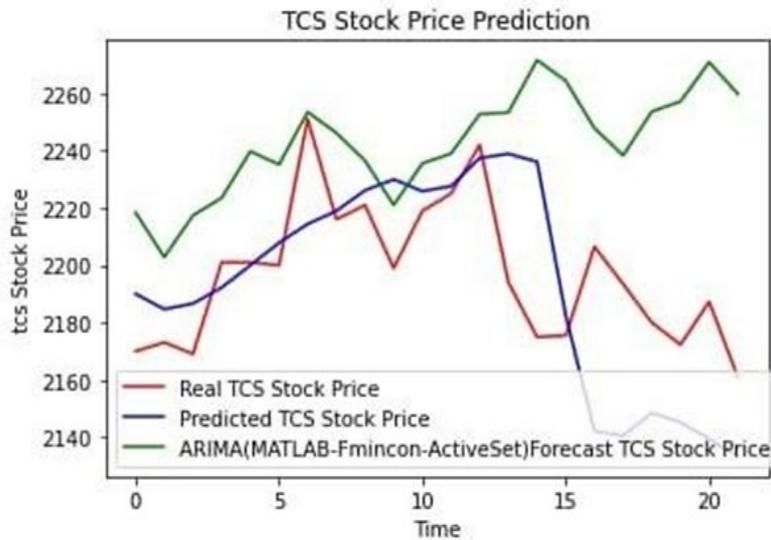


Fig. 5. Comparison of Real vs LSTM Predicted vs forecasted stock price of ARIMA model using FMINCON optimization using ActiveSet algorithm

TABLE I. Comparison of Predicted Stock Prices of First Six Days

Date	Actual Price	LSTM Predicted Price	SQP_Forecast Price	ActiveSet_Forecast Price
01/01/2020	2170	2190.0217	2218.3763	2218.3764
02/01/2020	2173.100098	2184.6433	2202.8670	2202.8668
03/01/2020	2169	2186.6335	2217.3858	2217.3859
04/01/2020	2201	2192.2085	2223.5238	2223.5243
05/01/2020	2201	2199.977	2239.7364	2239.1649
06/01/2020	2200	2207.8406	2235.1637	2235.1649
07/01/2020	2251.0500	2214.4038	2253.4821	2253.4835

6. Conclusion and Future Scope

Stock market prediction is a crucial activity for financial decision-making and development. Numerous research work has been carried out to accurately forecast the market for income using different techniques, varying from basic analysis to data-centric analysis. However, these methods are inefficient in forecasting market price and providing actionable recommendation or prescription.

Generally, ARIMA is used for time series forecasting. A new time forecasting model based on optimization technique i.e. multiplicative forecast ARIMA model using the FMINCON optimization technique has been proposed which help in forecasting the stock prices in the better way. This Model (ARIMA) estimate the numerically maximizes the log likelihood function, potentially using equality, inequality and lower and upper bound constraints. The dataset of the stock prices of TCS Bombay Office Company has been worked upon here.

In the proposed model, we have successfully studied, analyzed and compared the results obtained by the two models, i.e. LSTM and ARIMA using the FMINCON optimization technique using graphical representations as well as the values of stock prices. By introducing the FMINCON optimization technique we have at least 65 % (approximately) reduction in error rates.

In future, there is scope to implement the predictive model on stock price data based on Genetic Algorithm in combination with optimization of hyper functions like quadratic programming, minimax, pattern search. This will help in enhancing the businesses of the companies as well as the calculate the risk of investments.

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PROJECT MANAGEMENT AS AN ACTIVE TEACHING DEVICE THAT FOSTERS STUDENTS' EMPLOYABILITY

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Abstract: *This article reflects on the discipline of project management as a teaching device in the training of undergraduate and postgraduate students, facilitating them to acquire transversal skills, which enhance their employability. Results: A first preliminary result shows that, project management facilitates the acquisition of transversal skills useful for individuals' employability, thus it could be a valid teaching device to be used in higher education. Conclusions: Being rooted in practice, project management competes for having its professional dimension recognized at the higher education level, mainly due to lack of "project management culture". We suggest that a community of practice between professionals and academics could cultivate and generate a common effort for creating a culture of project management.*

Keywords: project management, transversal skills, experience, project-based learning, employability

1. Introduction

This paper presents the preliminary results of the focus groups and interviews delivered in summer 2020 in the field of the PhD research entitled "Project management as a sustainable teaching device to develop transversal skills in tertiary education", which is being carried out at the Department of Education, Language, Interculture, Literature and Psychology of the University of Florence, Italy.

At first, the PhD research will be briefly contextualised, in order to explain the relevance that the focus groups and interviews played for the identification of the factors that allow project management to be used as a teaching device at higher education institutes, with the goal of installing triple loop learning approaches [1; 2], able to support students in acquiring individually those transversal skills that foster their employability [3].

Secondly, a reflection on the link between project management and employability will explain the hypothesis that projects are informal learning contexts and project management is functional to the development of transversal skills in individuals involved in those projects, being cross-cutting, but still remaining a discipline on its own [4] that needs both knowledge and experience. Therefore, project management could be treated as an evolution of the project-based learning approach in higher education, being able to structure the learning experience as a mirroring of the professional practice [5].

After briefly explaining the protocols of the interviews and focus groups carried out in summer 2020, the preliminary results will be described, considering that the research is still in progress so there is still ground for a final interpretation.

As a conclusion, the practical experience of using project management as a teaching approach, developed at the Faculty of Engineering at the University of Valparaiso, Chile, will be presented,

showing that students effectively demonstrate the acquisition of transversal skills after attending the course structured through a project management approach.

These preliminary reflections have the objective to open the discussion on the possibility of using project management not only as a practice of delivering effective projects, but also as a teaching approach at higher education, in order to overcome some limits that the project-based learning approach itself may present. Therefore, we will suggest that an international Community of Practice [6] between practitioners and professors on “Project management as an active teaching device” could provide ground for reflection and innovation of the higher education teaching practices.

2. The Research Problem

We are living in a fluid [7] and complex [8] society, characterised by a constant transformation, due to innovation, technological development, globalization, climate change, sustainability and, recently, the global Covid-19 Pandemic. Since this transformation impacts all economic, social, and productive activities, it causes a revolutionary change in the labor market [9], requiring for people and organizations to be able to adapt and manage complexity [10], while also “finding alternative ways of thinking about causality”. [11]

In this post-modern “reflective society” [12], transversal skills become as important as professional and technical ones, being able to support the employability of individuals [13]. Transversal skills are “cross-sectoral skills that do not directly refer to a well-defined and/or technical field or application. Transversal skills cover all areas, as they refer to relationship skills, management, problem solving and behavioural skills”¹. [14]

In fact, “soft skills”² and “generic hard skills”³ are characterized by an elevated level of transferability between sectors and occupations and, as stated in the report of the European Commission “*Transferability of skills across economic sectors: Role and importance for employment at European level*”, “There is a link between skills transferability and the risk of losing a job or failing to find another one. Employability of individuals is based on specific skills, but transversal skills support it”. [13, p. 7]

The need to acquire transversal skills is also connected to the fact that individuals need to constantly manage change. As stated by Turner [15], “Change, and the need to manage change through projects, touches all our lives, in working and social environment” [15, p. 1] and “Project management is about converting vision into reality” [15, p. 2].

In fact, the research starts from the following hypothesis related to project management:

- Project management, as a method of planning, delegating, controlling, and monitoring projects [16], is a transversal area of learning, functional to the development of skills that

¹ Translation from Italian “abilità intersettoriali che non si riferiscono direttamente ad un campo ben definito e/o tecnico di applicazione. Le abilità trasversali coprono tutte le aree, dato che si riferiscono ad abilità di relazione, gestione, soluzione dei problemi ed abilità comportamentali”

² Defined as “non-job specific skills, closely connected with attitudes” [13, p. 9]

³ Defined as “technical and job-specific abilities, which can be applied effectively in almost all jobs in a majority of companies, occupations and sectors and in personal life and which are thus perceived as highly transferable. [...] 6 generic hard skills [...]: Legislative and regulatory awareness, Economic awareness, Basic skills in science and technology, Environmental awareness; ICT skills/E-skills; Communication in foreign languages” [13, p. 10]

facilitate employability⁴. It enables individuals to develop a set of cross-cutting, transversal, and vertical⁵ skills necessary to address risks and changes, to which all projects are subject throughout their life cycle.

- Project management has a transformative [17] value. In fact, it allows individuals to acquire an approach of critical reflection and transformative dialogue, while setting into crisis, in a constructive way, assumptions and meaning perspectives generated by the interpretation of own experience, in order to allow an independent development of transversal and vertical skills.

Therefore, the general objective of the research is to investigate the validity of using project management as an embedded⁶ [18; 2] teaching device capable of favouring in tertiary education students the sustainable⁷ development of transversal skills, described according to an outcome-oriented approach [20], thus enhancing students' employability [3].

3. The Link Between Project Management and Employability

Turner [15] states that the new management is the project-based management, in order for organizations to manage change, which is endemic in the complex world we are living, and to achieve performance improvement.

In fact, project management is the way projects are coordinated and projects are means by which we introduce change [16], in each aspect of life. Being projects informal learning environments, project management enhances learning from experience and promotes an “reflective practice” [21] for lifelong learning.

The reason why project management is able to trigger lifelong learning is connected with the intrinsic nature of being a project manager, as described by Gaddis (1959) in his historic article:

He [the project manager] is the man in between management and the technologist – the one man in the organization who must be at home in the front office talking about budgets, times schedule, and corporate policies *and* at home in the laboratory talking about technical research and development problems. But he is not a superman. He cannot be expected to double as a member of the executive committee and as a scientist equally well. Being a little of both, he is different from both – and it is precisely this quality which makes him so valuable. In his own right, he does what neither the front-office executes, nor the scientist can do: accomplish the aims of his corporate management, while serving as a perpetual buffer so that the engineers and scientists can meet the technological objectives that only they can define and only their output can meet [22].

Contextualising project management in the academic teaching approach, Garel (2013) states: Project management is not a “crossroads discipline”, which would mean diluting its content and making it a “receptable” or depository of what is produced elsewhere in academic disciplines. Project management exists in and for itself, with its own corpus of knowledge, concepts,

⁴ The definition of “employability” intended here is the one that Watts [3] defines as “sustainable employability” (p. 7), that is “[...] the ability not only to secure a first job but also to remain employable throughout life” ([3], p. 7).

⁵ Defined as “[how adults] develop more the complex ways of knowing, doing and being” ([2], p. 46).

⁶ As explained by Melacarne & Nicolaidis ([2]) “[it is] a whole-person approach to learning from experience. It is based on the premise that students learn from experience [19], there is no differentiation between the way disciplinary contents and transversal skills are taught” (p. 47).

⁷ “Sustainability citizens need to have certain key competencies that allow them to engage constructively and responsibly with today’s world” ([28], p. 9). Reference here is also made to the “sustainable employability” construct, as declined by Watts [3].

organisations, methodologies and lines of thinking. The status of project management as a “theory” continues to compete for recognition against its “professional” dimension. This tension is commonplace in disciplines rooted in practices, especially when they are new [4].

But it is exactly this characteristic of being “rooted in practice” that makes the difference in higher education context. In fact, as stated by Dewey in “Democracy and Education” (1916): Mere activity does not constitute experience. It is dispersive, centrifugal, dissipating. Experience as trying involves change, but change is meaningless transition unless it is consciously connected with the return wave of consequences which flow from it. When an activity is continued into the undergoing of consequences, when the change made by action is reflected back into a change made in us, the mere flux is loaded with significance. We learn something [23].

As McKimm & Jones (2018) pointed out in their study on the application of change models to curriculum development in formal education, “planning and implementing a new curriculum or major change requires project management approach and mental predisposition.” [24]

Therefore, there is no profession that can be considered outside of the “project management scope”. In fact, as highlighted by Guy Brown, Director of Northumbria University, London Campus, “But while project and programme management might be considered specialist disciplines for people with project and programme in their job title, the knowledge and skills involved are essential for many careers in today’s fast-moving, ever evolving world. Whether you are a nurse, a professional athlete or an IT manager, you could find yourself leading project or programme activity”. [29]

4. Project Management as an Evolution of Project-Based Learning

Hanney [5], analyses the use of projects as “primary means of structuring learning experience, as a means of mirroring professional practice” [5, p. 769], reconstructing the meaning of “project” as “ontological modalities of doing, being and becoming” (Ibid). Hanney draws his analysis on the work of Giddens [25], in order to make a historical, social and cultural investigation of the concept of projects, positioning so also “project-based learning as ontological modes of doing, being and becoming” [5, p. 770]. The driver of Hanney’s reflections is how the above-mentioned modes impact the way educators think and use projects as pedagogical tools of practice.

According to Hanney, who makes reference to the work of Helle, Tynjälä, and Olkinuora [26], project-based learning is under-theorised and seen as an “administrative framework rather than as an approach that fosters a personal transformation of the learner” [26, p. 771] and the method is mainly treated through manuals focused on the contents more than on the evidence of the impact on learning [26]. On the contrary, Hanney suggests that it is important to focus on the “what” before questioning the “how”.

The findings of Helle, Tynjälä, and Olkinuora [26] show that literature on project-based learning reports on project methods “adopted from an imagined professional practice, or from common sense understandings of the nature of a project” [5, p. 771]. The critique raised to this approach is about the educators’ ability to theorise the projects’ practice and therefore on the risk of undervaluing the learning benefits of the pedagogic approach.

In the historical appraisal between pre-modernity - as a doing ontology, modernity - as a being ontology and finally high-modernity - as a becoming ontology, Hanney connects the history of projects, with project-based learning and project management, explaining the need to embrace project management as a pedagogic approach mirroring the social need for extreme-reflexivity, for managing uncertainty and risks (perceived not only as threads, but also as opportunities).

Hanney concludes that, through a project management approach, specifically the Agile project management, educators would “embrace uncertainty and risk, let go the cherish notion of industry methods and look elsewhere for the authenticity of practice” [5, p. 781]. In fact, according to the author, project management methods, and specifically the Agile one, constitutes “a pedagogy in its own right and offers a model which not only mirrors the world of professional practice but may also offer an optimum or sufficient methodology for theorising project-based learning as a model for practice”. [5]

5. The Empirical Research Through Focus Groups and Interviews

The focus groups and interviews were carried out in summer 2020, as part of the exploratory approach of the qualitative research, which has the objective of analysing the aspects of the project manager's profession that, taught according to an embedded teaching approach, allow adults to acquire, through “reflective practice” [21], those transversal skills that permit them to adapt proactively to the complex context of today's world.

The sampling of the focus groups and interviews was randomized with the aim of involving professors who teach project management at tertiary education level, using, preferably, the PRINCE2® project management method, at least as a reference. No distinction was made with respect to the countries of origin of the professors or the university departments/faculties in which they teach. In fact, the goal of the interviews was to obtain subjective, experience-based interpretation on the methods used and results obtained through the teaching of project management, to conclude with the identification of best practices that would be transposed in the teaching device.

Four were the topics of the interviews and focus groups:

1. Experiential and informal learning through project management.
2. The Active Teaching Methodologies of project management.
3. The benefits perceived by the students at the end of the course of project management, in terms of transversal skills useful to employability.
4. Identification of Best Practices and Lessons Learnt.

The focus groups and interviews were carried out with the support of the project management professionals of Axelos Academia⁸, who gave a precious contribution in the identification of professors to interview, acted as facilitators and shared their professional experience during the discussion.

10 professors of project management were interviewed, out of which 1 was female. Professors came from the following countries: Chile, Germany, Italy, Mexico, United Kingdom (4 professors), Spain, Switzerland.

Averagely, professors had 12,2 years of experience in teaching project management, in a range between 5 and 19 years. 50% of professors shared the same years of project management teaching experience, that is 15.

50% of professors taught in a department/faculty related to engineering and 90% of them taught at level EQF7 (master's degree), although professors declared to teach also in other EQF Levels, such as EQF 5, 6 o 8 and other departments or faculties (included in an educational department). All professors were project managers before being project management professors. 60% of

⁸ The following professionals of Axelos Academia have supported actively this empirical research: Allan Thompson, PPM Product Ambassador, Axelos Ltd; Philip Hearsom, ITSM Product Ambassador, Axelos Ltd; Mark Hudson, Manager Axelos Academia, Axelos Ltd.

professors had no project management certification, while the rest was either a PRINCE2® practitioner, or a PMP (PMBOK) or certified according to IPMA standards.

Their contribution was highly relevant for the research, both thanks to the quality of the experience shared and because of the fact that it was possible to aggregate concepts confirmed in different countries and geographic areas of the world. Professors who participated in the focus groups didn't know each other before the event. This gave an international sight to the research and the possibility of having a transferability of the results. All focus groups and interviews were carried out virtually, through Google Meet.

6. Preliminary Results of the Empirical Research

The preliminary results presented in the paper are referred to the first topic of the focus group “Experiential and informal learning through project management” and to two categories created:

1. T1.2PMvsCT – how project management allows the development of transversal skills.
2. T1.2CT – transversal skills that project management allows to acquire.

The first category refers to those dynamics and intrinsic characteristics of project management, which can facilitate the acquisition of transversal skills in individuals. Specifically, reference is made here to the experience in project management, hence to the informal context of acquisition of transversal skills.

The transversal skills of category “T1.2CT” refer to those acquired thanks to the learning of project management, being in informal, non-formal or formal context.

6.1 How Project Management Allows the Development of Transversal Skills

Out of the codified segments, 11 project management facilitators were identified as capable of allowing the development of transversal skills in individuals. The results are shown in Table 1.

TABLE I. Project management facilitators that allow the development of transversal skills

Citations			
<i>Project Management facilitators – in order of relevance</i>	<i>Frequency</i>	<i>Cumulative frequency</i>	<i>Testimonies</i>
1. Logical and practical structure	15	15	5
2. Transversality	6	21	2
3. Experiential learning	5	26	3
4. Sharing with others	3	29	2
5. Overcoming challenges	3	32	2
6. Common framework and guideline	3	35	2
7. Common sense	3	38	2
8. Transnationality and internationality	2	40	1
9. Confidence	1	41	1
10. Focus on the objective	1	42	1
11. Multidisciplinarity	1	43	1
Total	43		

Source: self-elaboration

As it can be seen from the Table 1, 50% of the identified facilitators are represented by the first two: “Logical and practical structure” and “Transversality”. The first facilitator represents itself the 35% of the total and 50% of testimonies agree in this.

In fact, as stated by one of the testimonies “[...] *in completing an assessment, actually in any task, you need to follow a structure and a good way of developing that structure is by adopting Project Management principles*”. While with respect to “Transversality”, one of the testimonies stated, “[...] *the part on how to combine logic with creativity, so is this part, because normally Project Management brings the opposites together, I think, it's very important*”.

The following statements have also been detached with the goal of highlighting the role that project management plays in the life of individuals and in lifelong learning:

- “[...] *any person works as project manager in the lifetime, sometimes without really noticing it*”;
- “*I believe the more complex project management competence is to understand that you need it*”;
- “*It's about you having to explain to people that project management, whilst been a discipline and, yes, there will be people who are project managers as their profession, project management is something we will all do every day of our lives*”;
- “*Physics is international and mathematics is international, but project management is about humans in the international environment*”.

6.2 Transversal Skills That Project Management Allows to Acquire

Testimonies identified 22 transversal skills that could be achieved through learning project management in non-formal, informal, or formal contexts. These 22 skills have been elaborated through the analysis of 127 codified segments. Results are shown in Graph 1.

As it can be noticed in Graph 1, out of the 22 transversal skills identified by testimonies, 6 can be detached as the most relevant:

1. Communication (17%)
2. Teamwork (8%)
3. Presentation (7%)
4. Leadership (6%)
5. Problem solving (6%)
6. Learn to learn (6%).

Altogether, these six transversal skills represent the 50% of all citations.

With respect to “Communication”, 100% of testimonies agree with it. In fact, as stated by one of the testimonies “[...] *how you communicate, but it's not just how you communicate to different audiences. You've got various stakeholders, you've got the team itself, you've got customers and an agile context, which is incredibly challenging and then you've got the internal stakeholders who need to be reassured [...]*”.

Moreover, with respect to presentation and communication, the role that project management plays in the acquisition of these skills is described as follows “[...] *presentation and communication skills; and communication skill is not really about are you able to talk, no. I mean, are you able to communicate at the right level using the right content as well as the presentation skills.*”

As preliminary conclusion, it can be stated that professionals and professors who deal with project management are aware of the transversal skills that this “discipline” allows to achieve. There is also awareness that teaching project management supports the employability of students.

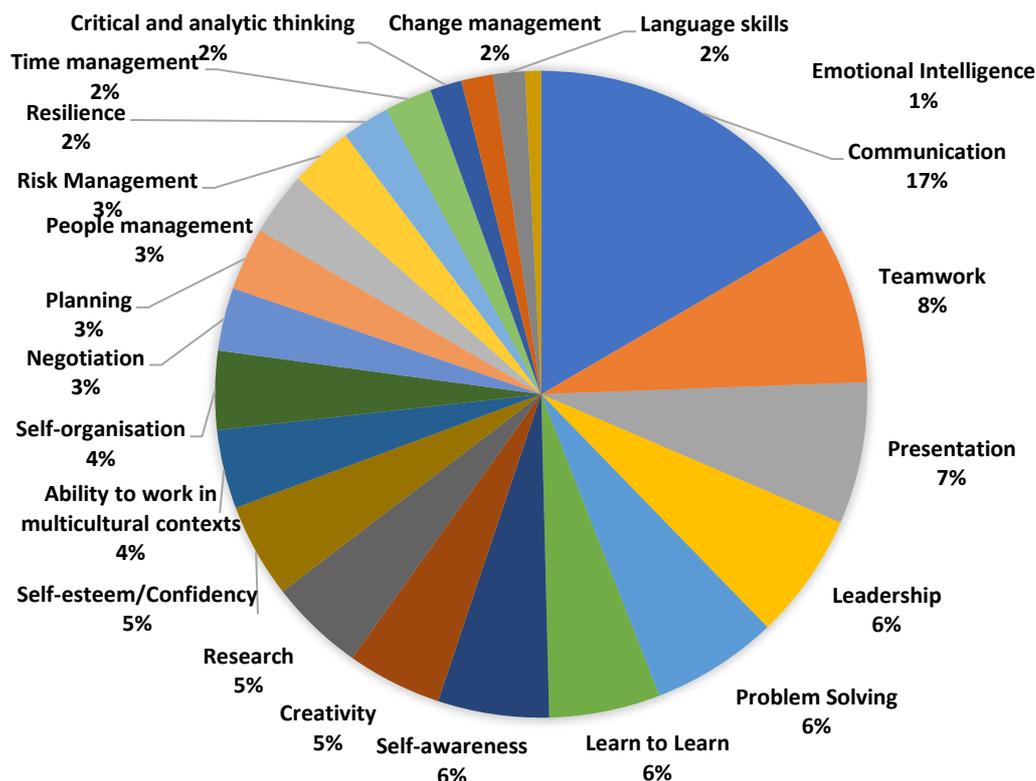


Fig. 1. Transversal skills that the project management learning allows to acquire.
Source: self-elaboration

As stated by one of the testimonies, one of the primary difficulties of including project management at higher education level is a cultural problem, since sometimes “*they don’t know what it is about*”.

7. Experiences in Undergraduate and Postgraduate Programs

During the year 2020, concepts and standards of Project Management, based on PMI standards, were included in undergraduate programs, of the University of Valparaíso and postgraduate of the Casa Grande University of Ecuador.

According to “PMBOK Guide”, publication of the Project Management Institute, (PMI) [27], the competencies of the Project Manager are three sets of key skills: a first set of nature “Technique,” which includes those knowledge, skills, and behaviors related to specific areas of the project management challenges of his role, the second set of Leadership skills, required to lead a team towards their business goals and a third set relates to the field of Strategic Management and Business, focus on knowledge and expertise to best achieve business results.

Using this framework as a reference, the topics of Project Management, based on PMI standards, focused on two areas of knowledge described in the PMBOK [27]:

"Project scope Management", which includes the processes required to ensure that the project includes all the work required, and "Project Risk Management", which includes the processes for carrying out management planning, identification, analysis, response planning, and monitoring of a project's risks.

This theoretical framework was included in the subject of “Strategic Direction”, process-oriented “Strategy Implementation”, offered to 23 students from the 5th year of the career of Industrial Engineering, Faculty of Engineering of the University of Valparaiso and in the “Competitive Strategy and Innovation”, offered to 21 professionals from different areas, participants in the program “Master in International Business” of the Universidad Casa Grande de Ecuador. In both programs, the attendees were organized in project teams that developed solutions to specific problems, contextualized in the implementation of digital transformation projects.

From the experience observed in the application of the standards of project management, it should be noted that the three sets of key skills mentioned, were observable in both undergraduate and graduate students, who developed projects using case studies applied to their business reality. In this latter group, the projects covered start-ups, process optimization of the productive area and commercial enterprises of the food industry, public institutions, and supplier management of a port services management company. Both in the design of the solutions and their presentation and defense, the increase of critical analysis was evidenced through the integration of concepts and experiences arising through practice, as well as the elaboration of proposals through collaborative work. These observations were common in both programs, confirming Project Management as a learning environment that contributes to the acquisition and development of cross-cutting competencies.

8. Results and Conclusion

8.1 Results

The monitoring and evaluation of the results of the teaching-learning process that uses Project Management, evidence that its postulates facilitate the acquisition and development of skills, transversal to both undergraduate and postgraduate courses, generating a space of complexity that requires participants to harmonize different solutions around common goals.

8.2 Conclusions

The management of projects, while being recognized as a professional practice, still needs a major recognition, at higher education sector, as a discipline on its own, capable of allowing students to be “sustainably employable”. We suggest here that there is a need for a Community of Practice between professionals and researchers, which focus on the wide spreading of a culture on project management, as capable of addressing the dynamics of an environment in constant evolution.

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ALCOHOLISM AND ITS IMPACT ON THE WORKPLACE: A BRIEF ANALYSIS

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Abstract: *In Mexico, alcohol is a harmful substance that is legally and socially accepted, the consumption of which, according to data from the latest National Survey of Addictions, has been gaining ground, especially among young people. Thus, it has also become a serious social problem that affects individuals in different areas, mainly at the personal, familiar, social and work level. In this article, the analysis of the impact of alcoholism at the workplace will be carried out, since it has been proven that it generates problems such as accidents at work, absenteeism, staff turnover, loss of supplies, chronic and degenerative diseases, in addition to generating conflict due to behavior change resulting from disinhibition, all of which impacts the performance and performance of the organization. Primary and secondary sources of information will be analyzed, referring to reports from national and international health institutions, therefore this work is based on documentary research and has a descriptive scope. It concludes with the need for organizations to be alert to this phenomenon, since it generates excessive expenses that can be avoided with prevention and treatment policies, and not only with sanctions.*

Keywords: alcoholism, work, performance, impact, organization

1. Introduction

Alcoholism has become a serious social problem that affects individuals in different areas, the most important being individual, social, familiar and, of course, work.

The objective of this article is to reflect on the impact of alcoholism in the workplace, as well as to identify alternatives to reduce it. It is a documentary investigation of primary and secondary sources of information with a descriptive scope and a non-experimental approach.

The article is divided into three sections, the first of which deals with theoretical and contextual references regarding the concept of alcoholism and addictions; the second addresses the issue of alcoholism and its impact on the workplace and how diverse national and international organizations have designed prevention and treatment strategies; The third and last section concludes with some reflections and recommendations regarding on how to deal with this phenomenon.

2. Theoretical and Contextual References

Alcoholism is a disease caused by the abuse of alcoholic beverages [1]. It is a type of drug dependence, in which there is physical and psychological addiction.

In 2001 Tapia [2] affirmed that the consumption of alcoholic beverages is present throughout the history of humanity and is frequently associated with the coexistence situations that

occurred in the daily life of many cultures. Since ancient times, for example, in the pre-Hispanic period in which alcohol is linked to numerous political, economic and religious activities, therewith the fermentation process of grains and fruits was perfected to achieve a substance that caused special states of relaxation, trance or hallucination.

When talking about alcoholism, the concept generally refers to addiction or drug dependence, which according to the World Health Organization (WHO) is "a state of periodic or chronic intoxication produced by the repeated consumption of a natural or synthetic drug [3].

Addiction is directly related to the term of dependence, defined by the WHO in 1982 [3] as "a syndrome that implies a behavior pattern in which a high priority is established for the use of one or more determined psychoactive substances, compared to other behaviors usually considered as more important" (Ibidem).

In 1948, alcoholism was recognized by the WHO as a disease, and today it has become one of the most serious health problems that exist in the world, since it is considered a chronic, degenerative, progressive and deadly disease.

There are many factors associated with addictions, but none of them is determining; rather, it is the combination between them that makes this disease manifest itself definitively [3]. This makes the understanding of this phenomenon even more complex.

Based on the 2016 National Survey on Drug, Alcohol and Tobacco Consumption [5], 71% of the population in Mexico has consumed alcohol at some point in their life and 33.6% report excessive consumption in the last year. Of those who consume alcohol, 53.1% indicated that they had done it for the first time at the age of 17 or younger, 41.3% did so between the ages of 18 and 25, while 5.6% between the ages of 26 and 65. 39.8% of young people between 12 and 17 years old have consumed alcohol at some point in their life. Of these, 15.2% of young people report an excessive consumption of this substance, meaning that the data shows that the consumption of alcohol in minors has had a significant increase in recent years.

Considering that alcohol consumption represents one of the main risk factors for disability and premature death, the figures presented are alarming [6].

As indicated, alcohol is a drug that causes dependence and its excessive consumption is associated with more than 200 illnesses and injuries; it is responsible for causing severe social, mental and emotional damages, which is why its consideration is imperative.

3. Work Life and Alcoholism

The diverse demands of today's working life put workers at constant risk. Rapid changes, shortage of job vacancies, precarious wages and salaries, excessive working hours, the work environment, shift rotation, job demands, and job instability make workers vulnerable, in consequence, they seek stimulating or relaxing substances, such as drugs and alcohol.

In all work areas we find people who suffer from addiction problems, which not only affects the person, but also causes long-term damage to the organization they are inserted into. The effects generated by the alcoholic employee are frequent absenteeism (authorized or unauthorized), constant staff turnover, delays, work accidents, poor performance, not very tolerant behaviors, rarefied work environment, and a notable increase in premature deaths due to both acute and chronic diseases [2], [7].

Several studies show that the consumption of alcoholic beverages cause a decrease in productivity, quality and competitiveness; it affects the health of workers, in addition, it increases accidents, absenteeism and social expenses [8], it generates large economic losses, as well as other consequences [9].

One of the main difficulties in “employees with addiction to alcohol and drugs is that they have five times more accidents at work, and present seven times more claims for illness” [10]. Without a doubt, it is a higher figure compared to the accidents of people without this type of effect.

For the World Health Organization [11, p.3] “problems related to alcohol consumption are responsible for 54% of work accidents, of which up to 40% of these could be fatal”. Thus, the issue of the impact of workplace accidents negatively affects the safety and health of other workers, causing injuries and more disabilities that companies have to face with money and time.

Alcoholism also has a great impact on productivity, “and this is due, on the one hand, to the decrease in the worker's ability to concentrate on the task, and even to the slowdown and difficulty of making movements, depending on the amount of ingested alcohol” [12, p.59]. Causing not only delays in their job, lowering productivity by up to 50% due to their state of intoxication. Likewise, absenteeism days used by general illnesses and violence problems are caused by alcoholism and other addictions [13].

Referring to the arguments above, another issue that is important to address is the professional safety of workers since alcoholism does not only impact productivity, but also triggers factors of conflict that can endanger collaborators in the work area or inside the personal life of the alcoholic.

Alcohol consumption can be considered a risk factor” [12, p. 55] when in situations outside of the workplace the person consumes alcohol, a risk factor develops threatening for safety and health of the same or of third parties: “the impact that such consumption causes on occupational health and safety is when alcohol should be considered a risk derived from work” [13, p. 55]. Although, in the second case, it is based on the way in which the worker perceives the workload and stress, leading to an increase in absenteeism and generating a problem in the company's safety.

Another of the impacts that alcoholism has on companies is the bad image that it can cause. Since many of the people dealing with addictions are in charge of the positions in which they function as the face of the company, these addictions are in contact with customers and suppliers; so, it is important to positively deal with them, as it not only affects the expectations of external people, it can also affect sales or production.

There are certain sectors that are more prone to alcoholism. According to a study by the United States Government, mining and construction are the sectors that are the most prone to alcoholism, that is, the least qualified jobs are those in which alcohol is abused the most. On the other hand, the jobs that demand more qualification experience increase in stress and in liberties; in consequence, there is more propensity to the use of other drugs [14].

As stated by the Organization of American States [15], and the National Council for Addiction Prevention and Control [16] identify that some of the risk factors in the workplace are:

- Shifts that alter the sleep cycle.
- Repetitive and poorly motivating jobs.

- Easy availability to the consumption of alcohol.
- Easy availability to licit or illicit substances.
- Instability in employment.
- Work stress or stressful environment.
- Frequent job transfer.
- Adverse weather conditions.
- Pollution and environmental toxicity.
- Isolated jobs without contact with colleagues.
- Inappropriate supervisory or leadership styles.
- Existence of micro-trafficking in the workplace.
- Handling of psychoactive chemicals without the necessary protections.
- Organizational culture that tolerates consumption.
- Performance requirements that are too high or too low.

As observed, the accelerated work life of the 21st century conducts the working person to trigger different types of addictions. In this regard, there is an entire national and international legal framework regarding the prohibition of alcohol consumption in the workplace.

In Mexico, the Federal Labor Law in its first section from the 261 article, establishes that the use of alcoholic beverages is prohibited for workers during the provision of the service and in the twelve hours prior to its initiation. The General Health Law also considers a section on alcoholic beverages, which was amended in 2015. In addition to the above, on May 8, 2018, the decree that establishes November 15 as the National Day Against the Harmful Use of Alcoholic Beverages, operates as a way to raise awareness about the risks of consuming alcohol.

At the international level, the International Labor Organization (ILO) is fighting to prevent and combat problems of this nature, which is why since 1996 the organization has designed a manual on “Treatment of issues related to alcohol and drugs in the workplace” [7], which specifies how to advert if a worker arrives in poor condition, the occasions that it begins to become a more serious problem and what measures can be taken to prevent the situation from worsening.

In addition to the normative framework of the ILO, the Organization of American States (OAS), through its Inter-American Drug Abuse Control Commission (CICAD), has various strategies against drugs, including alcohol.

Similarly, the Pan American Health Organization (PAHO) and the WHO, have been dedicated for years to promote health and development, preventing the consumption of tobacco, alcohol, drugs and other psychoactive substances that affect health conditions [17].

The effects of the consumption of alcohol and other drugs bring various problems to workers, both at a personal and work level, therefore, the employing organization suffers from several of these consequences due to the fact that, with absenteeism, staff turnover and productivity becomes reduced; the performance of the workers is stunted, thus causing a negative impact on the complete entity. Similarly, the risk of occupational accidents increase, directly affecting the organization's economy.

Therefore, various national and international organizations have discussed the need to establish policies to reduce the consumption of alcoholic beverages in workers, in addition to the need to make constant evaluations to detect the levels of alcoholism that employees maintain.

Following the ILO, even though the employer can take measures to punish improper labor conduct, it is preferable that they refer them to counseling, treatment and rehabilitation services rather than applying disciplinary sanctions; in case that the worker does not fully cooperate with the treatment, the employer may take the appropriate disciplinary measures [7].

These types of programs do not exist in Mexico; the problem is eradicated from the organization the moment the person is fired, however, the problem is not in any way uprooting, it is hiding and getting worse. Almost a decade ago, in Mexico, about 10% of workplace accidents were related to acute alcohol intoxication, and the number of workplace accidents among people who have consumed alcohol is between two and three times higher than those suffered by other workers [18].

It would be prudent then, whether at the organization or industrial level, to organize support groups for the treatment of this type of disease; as well as having a strategy to cope with alcoholism, as well as to prevent it in employees.

4. Results and Conclusion

Organizations must be alert to addictions, since they undermine the health of workers and generate excessive expenses. According to the WHO alcoholism represents a considerable health, social and economic burden for society as a whole [3].

Thus, prevention and evaluation policies should be established to avoid alcoholism and its consequences in the workplace, in addition to considering this phenomenon as a disease that needs referral (health service, counseling, treatment and rehabilitation) and not just a sanction.

Alcohol is a substance that alters the central nervous system, therefore it directly affects the functioning of the brain. In small doses it produces disinhibition, euphoria and stimulation; in large doses, it produces corporal incoordination, as well as slowing the speaking and thinking process; in large doses it can cause a coma, congestion and even death.

As previously argued, the consumption of alcohol and other substances are an important problem for organizations, as their repercussions cause a great impact in the workplace, generating high costs.

Consumption related problems of alcohol are so many and so diverse, the strategies and solutions have to adapt to the circumstances of individuals of each organization. Both the environment and the processes of work influence the consumption of alcohol, but it should be noted for the intervention of other factors such as the personality of the worker.

The Mexican government has established policies to regulate and prevent alcohol consumption, for example, the alcohol-free driving program, even though it is intended to prevent people from driving while intoxicated. Controlling the sale of alcoholic beverages at certain times can limit their consumption, as well as applying special taxes to discourage their purchase. Alcohol consumption can also cause dependence and these measures should be included in evidence-based preventive programs to help raise awareness and educate the population [19].

The consumption of alcoholic beverages is a cause of 60 different diseases and a risk factor for accidents and injuries, both on and off the job. Although Mexico is not a large consumer (5.7 liters per capita), the main problem is the pattern of consumption. Mexicans drink large amounts of alcoholic beverages in short periods of time, the so-called binge drinking [20]. This type of behavior is related to various health problems and increases social, economic and health care costs. In addition, consumption among young people is on the rise and the age of onset of

consumption has been decreasing. This is undoubtedly a phenomenon that should be studied in order to make decisions within the companies where people carry out their work activities.

Generally, the policies to treat alcoholism in the workplace can be viewed in two spheres, the first regarding awareness and information about what alcoholism is and represents; and the second with the duty to fulfill certain postulates for the prevention and treatment plans.

In conformity to the completed analysis, it was found that there are organizational circumstances that promote alcoholism (competition, long working hours, stress, work hours, negative work environment, etc.), for which the administration must also be sensitive regarding this situation and aim, as far as possible, to prevent this disease, through a healthy organizational culture, upward and downward communication, creation of recreation and coexistence spaces where healthy lifestyles are promoted, employee recognition, employee turnover schedules, appropriate rewards, etc.

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NUMERICAL SIMULATION OF A HIGH-SPEED BUMPER MADE WITH 6061-T6 ALUMINUM ALLOY

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Abstract: *In the present investigation, the study of elastic and plastic deformations in an aluminum alloy bumper impacted frontally against an obstacle of 1000 kg has been carried out, employing LS-DYNA® from ANSYS Workbench. For the frontal impact, the speed of the aluminum bumper was 33.33 m/s. According to the results, the design presented good mechanical resistance. Plastic deformations that do not affect the mechanical integrity of the bumper or the general structure of the structure were found; however, in the event of a subsequent collision, the bumper could not have as much resistance and reach the breaking point where it can no longer safeguard essential elements of the car such as the cooling system or the engine.*

Keywords: aluminum, mechanical resistance, deformations

1. Introduction

In the last half-century, the development of computational and communications technology has allowed transferring of scientific proof done in laboratories to computational data with high accuracy [1]. In the field of engineering, modeling and simulation methods have become increasingly important for the analysis and design of systems since they represent a strong impulse for research and the growth of scientific knowledge [2]. The main advantages of computational experiments are; no physical risks, or moral damage, or attacks on the pocket of the citizen; in addition, they provide answers for various alternatives or operational configurations of the object or situation under study, very close to reality[3].

Laboratory experiments carried out on the real system under study (or target-system) are always valid since the real system is obviously suitable for any experiment [4]. One of the major disadvantages of experimenting with real systems is due to the facts that they are usually under the influence of a large number of variables, sometimes inaccessible (disturbances), and that several really useful outputs are not measurable since they constitute internal states of the real system. In the simulated world, all input and output variables are accessible [5].

Modeling a system implies, together with the description, that the stipulation of its experimental framework should necessarily be accompanied [6]. When the set of experiments supported by the model gets established, it offers the possibility of extending the simulations beyond the range of the experiments that can be carried out on the real system as it is the only technique available to analyze the behavior of arbitrary systems, as an alternative to direct experimentation [7].

In this work, LS-DYNA from ANSYS Workbench allows the integration of simulation of linear, non-linear, implicit, and explicit deformations, which occur in milliseconds in metal-metallic systems [8]. The arrangement of these studies has several appliances in the automotive, aerospace, manufacturing, electronics, and defense industries [9].

This knowledge leads to the advanced evaluation of clue aspects in the manufacture of metallic parts for appliances in the automobile and aerospace industries with a high percentage of accuracy; [10] which will represent a considerable reduction in economic losses in physical impact tests, and the analysis of failures after a collision. It will also give the confidence and safety interval that increases the sales price of the parts [11].

2. Experimental

The Research Council for Automobile Repairs (RCAR) high-speed offset crash test was developed at the suggestion of the insurance industry. The RCAR test specification describes a front crash and a rear crash. The damage, because of a side crash, is considered theoretical damage within the RCAR procedure. For this, a partial replacement of the sill and a replacement of the driver's door will be calculated [12].

In the front and rear impact tests, the vehicle overlaps the face of the barrier by $40\% \pm 25$ mm (Fig. 1) at 0° (parallel) to the front/rear of the vehicle. The 1000 kg mobile barrier is propelled into the test vehicle with an impact speed of 33.33 mps [$+1/-0$ km/h].

To ensure the deformation in the high-speed frontal impact and to minimize the damage of the structural member in the high-speed crash, the maximum collapse of the structure should be smaller than the collapse load in the bumper beam.

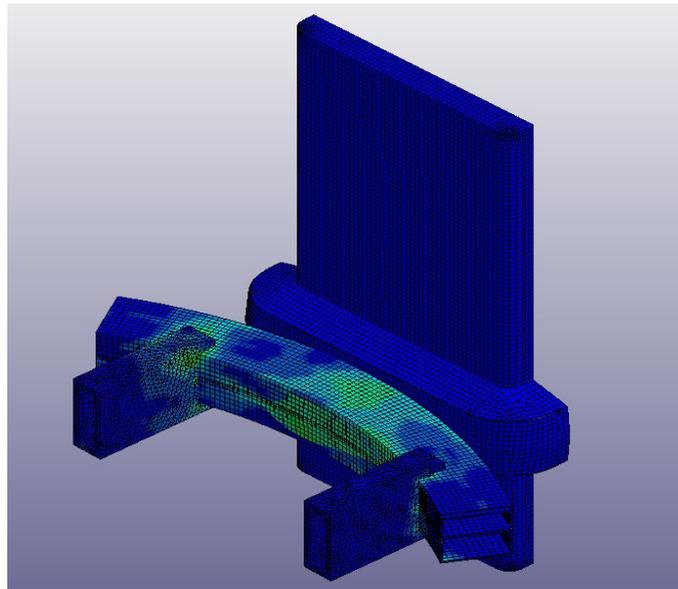


Fig. 1. High speed bumper impact at 33.33 m/s in LS DYNA Workbench

To set the values of the specification design in the front bumper, three physical variables had to be derived by analyzing the vehicle-level performance of the frontal impact under the high-speed (56 km/h).

In addition, the deformation energy of the bumper should be greater than the initial kinetic energy of the vehicle under the high-speed crash condition to prevent the damage of the structural part of the car.

3D Modelling and simulation of high-speed crash conditions. The 3D design was done by using the Workbench modeler, under National Highway Traffic Safety Administration (NHTSA) considerations as shown in Fig. 1. [13].

3. Results

Mechanical characterizations of an aluminum alloy 6061-T6 were used among the modeling parameters as shown in Fig. 2.

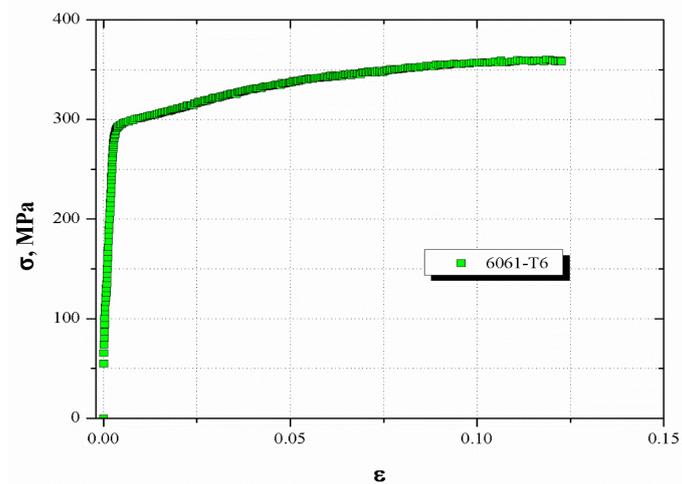


Fig. 2. True Stress-Strain curve aluminum Alloy 6061-T6

Using the properties obtained from the mechanical characterization of a 6061-T6 aluminum alloy in a stress test, it was possible to enter the control parameters in ANSYS Workbench LS-DYNA to carry out the numerical simulation of a frontal impact at a speed of 33.33 m / s. Fig. 3. shows the evolution of the response related to the displacement of the bumper. The starting impact force of 52.41 kN descended as the bumper began to absorb the force of the impact in the form of elastic and plastic deformation, Fig. 4.

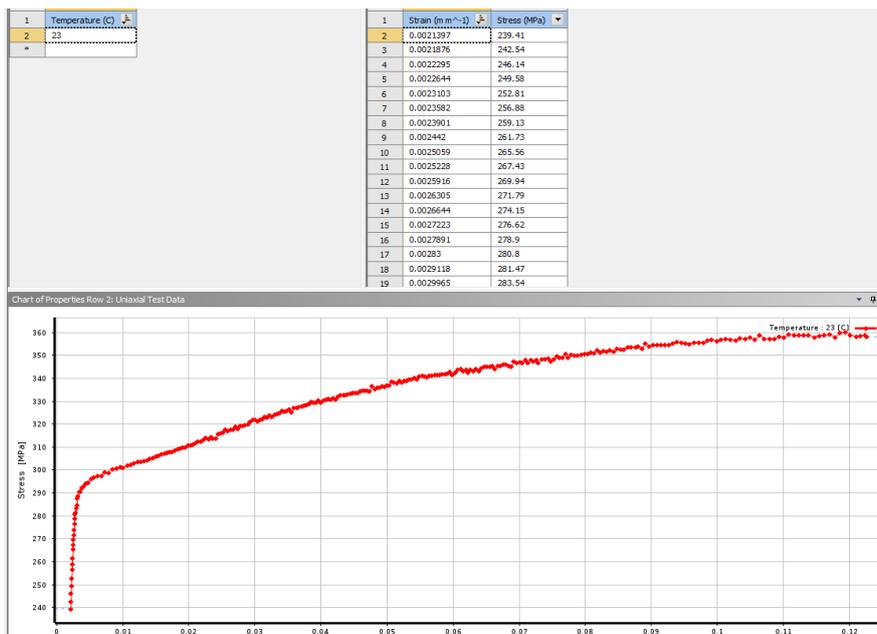


Fig. 3. True Stress-Strain curve aluminum Alloy 6061-T6 in LS DYNA Workbench

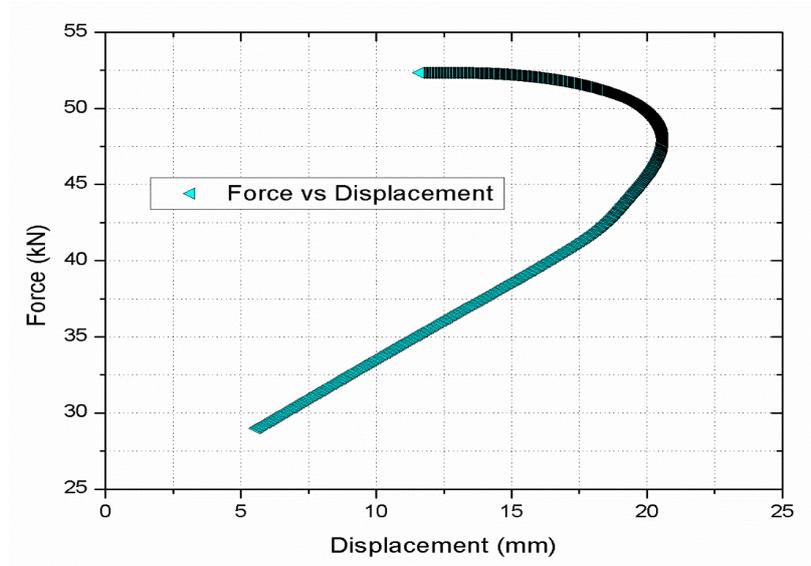


Fig. 4. Force vs Displacement evolution of bumper impact

Fig. 5. shows the displacement vs. time graph. The bumper suffers a maximum displacement of 20.57 mm at 1.79 ms. In terms of mechanical resistance, the results are very positive since the deformation caused by the impact is quite good, demonstrating that the bumper model has high mechanical resistance capable of absorbing a large amount of energy in the form of plastic and elastic deformation.

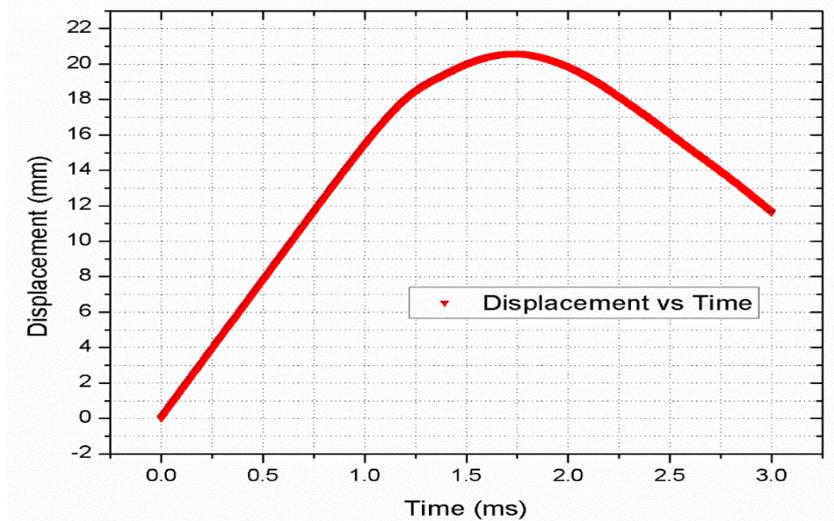


Fig. 5. Displacement vs time evolution of bumper impact

Fig. 6 illustrates the evolution of Von Mises's efforts. All the plastic and elastic deformation concentrated in the center of the bumper, considered as the maximum distance area from the center according to the 3D model of the bumper which demonstrates that even though there is a stress concentrator in that area, the bumper is capable of absorbing a large amount of energy in the form of elastic and plastic deformation.

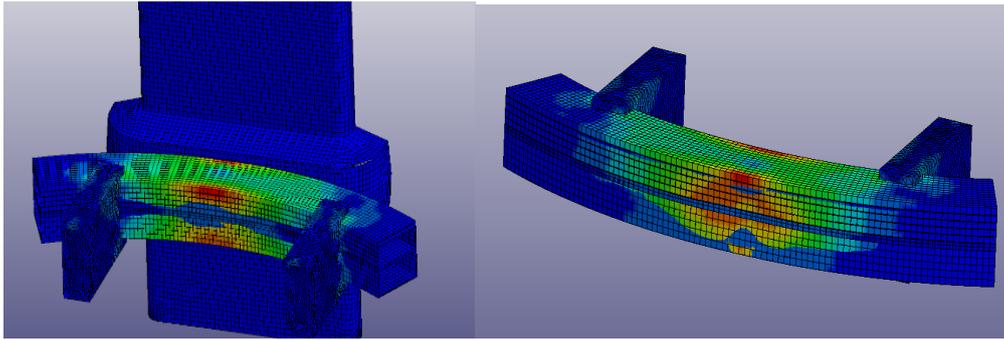


Fig. 6. Von Mises evolution of bumper impact

4. Conclusions

The ANSYS Workbench LS-DYNA tool provides results that are close to reality. There are many possibilities regarding the evolution of an impact, that is, the bumper could receive one or more collisions after the first impact which can affect the mechanical integrity of the structure, engine, cooling system, etc. However, this simulation was performed using the parameters and conditions dictated by the National Highway Traffic Safety Administration standard. Conducting experiments requires material resources and time for the design of experiments. The development of an impact at high speed would help to validate the results of the simulation. The obtained results demonstrate that the design of the bumper of a 6061-T6 aluminum alloy has very good structural resistance since the displacements and deformations are relatively small at high speed. A maximum displacement of 20.57 mm could be measured, which is a relatively low value. The efforts concentrated in the center of the bumper, besides according to the analysis of Von Mises, there are moderately high efforts that produce small elastic deformation in the structure.

The mechanical integrity of the structure was not severely affected; however, in a subsequent impact, it could fracture. Further optimization analysis is necessary in this case. Redesigning the profile could increase the cross-section of the bumper. In addition, it is necessary to carry out a study using the welding sections and including them in the bumper manufacturing process, always remembering that welding processes affect aluminum alloys and might cause a loss of mechanical properties; however, they can be restored by thermal treatment.

The scope of the study carried out for aluminum alloys as a potential alternative to high-strength steels, frequently used in the automotive and aerospace industries, put in evidence the limits of experimental research on the plastic deformation and fracture physical of these alloys. The modeling and simulation of deformation and possible impact fracture of aluminum castings show high accuracy, determined by the precision of the analysis numerical involved.

For the automotive and aerospace industry, it would represent a notable reduction in production costs and impact tests and would also be setting confidence standards. For Insurance companies, there would be a reduction in the high costs of analysis and repair of damage due to impact and collision.

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IMPACT-FACTOR OR INFARCT-FACTOR: THE CASE STUDY OF SCOPUS PUBLICATIONS IN KAZAKHSTAN

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Abstract: *This article gives an overview of the publication activity of Kazakhstani scholars from 2011 to 2020. It has been identified that the number of publications in the journals indexed in Scopus increased rapidly in the abovementioned period, along with the number of articles published in predator journals. More detailed investigation of the number of scholars in the field of Language and Literature awarded the PhD degree and their articles mandatory for defense has identified that more than 80% of scholars publish in predator journals. Such shocking results correspond with the time of adoption of governmental publication requirements. To solve the problem, we suggest expanding the number of accepted databases the journals are indexed in, and prolonging the number of years of study and research.*

Keywords: Scopus, publication, PhD degree, predator journals, Kazakhstan

1. Introduction

Most scholars in post-Soviet countries, including Kazakhstan, are currently struggling to get published in the scientific journals indexed in Scopus and Web of Science. Of course, the publication of articles in well-known and peer-reviewed scientific journals reflects the research productivity of individuals, educational organizations, and even countries. But in Kazakhstan, the scholars' primary aim is not about showing the research performance to the world, though. Indeed, they are forced to get published in the abovementioned databases for getting the PhD degree, getting the title of associate professor or professor, applying for a research grant, or, what's the worst, getting the labour contract prolonged for the following academic year.

In 2011 the Ministry of Education and Science of the Republic of Kazakhstan introduced some changes to the rules of awarding the scientific degrees [1]. The scholar can get the PhD degree in case of having a review and at least two scientific articles in journals of the first or second quartile according to Journal Citation Reports of Clarivate Analytics. In other cases the minimum of one article in an international peer-reviewed scientific journal that has an impact factor according to JCR data (or indexed in the Web of Science Core Collection database) or CiteScore percentile at least 25 (twenty five) in the Scopus database is required. Getting the title of associate professor and professor requires at least two and three such articles, respectively. Such requirements have led to hysteria in the scientific community of Kazakhstan along with the joke of comparing the phrase 'impact-factor' with the phrase 'infarct-factor' as if the abovementioned requirements are factors leading to heart infarction.

Publishing in predator or counterfeit journals is more serious consequence of high requirements for getting promoted in Kazakhstani scientific and academic community, though. According to Vít Macháček and Martin Srholec, Kazakhstan is one of the most affected countries in terms of predatory publishing, having 17% of articles in the predatory category in 2021 [2]. The research by the same authors in 2018 identified that Kazakhstan is the country with the largest tendency to publish in predatory journals (18%) [3]. But this indicator is not the historical maximum. According to Tatiana Savina and Ivan Sterligov, the share of Kazakhstan in potentially predator journals was almost 50% [4] in 2015.

The primary reason for predator publishing is that scholars think that publication in high-rated journals needs payment. They are now forced to collaborate with so-called publishing agencies, which promise promoting the article for a fee of 1000 US dollars at least. The search of ‘services of Scopus publication’ (in Russian) in Google retrieves approximately 399 thousand results. According to the information on the website of such an agency, the fee includes the translation of the article, checking its uniqueness, editing, proofreading, choosing the journal and corresponding with the editors [5]. In most cases the scholars are sure they are paying for the journal itself, i.e. for publication. But according to Aliya Ospanova, Regional Director of Elsevier company for Central Asia and Azerbaijan, out of 16709 articles published by the Kazakhstani scientists, only 823 have been published in official paid open access journals [6]. It means that the scholars paid for correspondence, or, the more probable, for the publication in so-called predator journals, which, we dare assume, the abovementioned agencies collaborate with. Some scholars have already calculated the approximate ‘expenses’ of Kazakhstan on such publishing practices [7]. And all these is happening despite various seminars on how to publish in Scopus for free held at least once a year in every educational and scientific organization in Kazakhstan.

Another reason of becoming the victim of predator publishing is reluctance to wait for long peer-review process of high rated journals, which might not even accept their articles after reviewing. Most scholars choose to rely on the abovementioned agencies which promise not only reviewing, but also the publication, and reflection on the database in a short period of time, for example, in three-months period. This is especially relevant to PhD students, who can defend their thesis for free only a year after finishing the PhD curriculum [1]. After a year they are fined for not meeting the deadlines. Some scholars send one and the same article to several journals, hoping to get accepted in one of them. In case the journal, for some reason, is delisted from Scopus during the reviewing process, then the authors just send the work to another journal, thus violating the scientific ethics.

One of the biggest culprits of predator publishing is the low level of English, as most journals accept articles in this language. English is taught as a foreign language in Kazakhstan, and most people do not have a competence of academic writing in English. Some scholars publish in the Russian journals indexed in Scopus. It is worth noting, that there are only five journals in Kazakhstan indexed in Scopus [8].

In this article we shall consider the Scopus publications by Kazakhstani scholars between 2011 and 2020. We have chosen this time period to better assess the impact of regulatory acts on scientific activity. We suppose that the number of articles in journals listed and delisted in Scopus rapidly increased in this period, and we assume that most of them appeared in predator journals. Moreover, we assume that the number of articles in non-predator journals did not increase with the issuance of governmental acts on awarding the degrees.

2. An Overview of Publications between 2011-2020

The search in Scopus retrieved 13101 documents published by Kazakhstani scholars between 2011 and 2020. The number of articles in the database increased steadily year by year (See Fig. 1). At the beginning of the period the number was 513 which increased by four times at the end of the period. We assume that the increase is related to the issuance of above-mentioned governmental acts on awarding the academic titles.

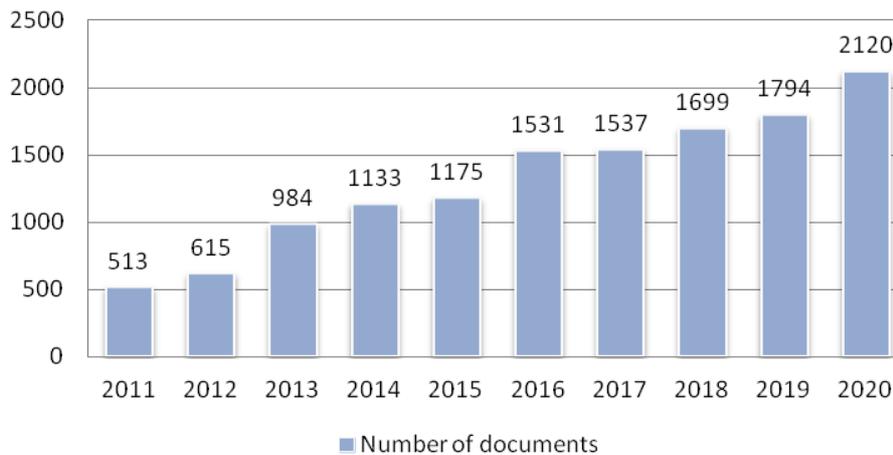


Fig. 1. The number of articles by Kazakhstani scholars in Scopus database between 2011 and 2020

To identify what percentage of article were published in predator journals; we filtered the results by year, and checked the indexation of the journals among the top 10 results of source titles. We have excluded the source types like conference proceedings, books, book series, and journals with a percentile less than 25, as these types of publications are not counted for getting a degree or academic title. The indexation was checked according to the note ‘indexation discontinued’ on the Scopus description page of the journal. The following results have been obtained:

TABLE I. The Minimum Percentage of Articles in Delisted Journals between 2011 and 2020

Year	Total number of articles	Journal 1	Journal 2	Journal 3	Journal 4	Journal 5	Journal 6	Journal 7	Journal 8	Minimum number of articles in delisted journals	Minimum number of articles in delisted journals, %
2011	513	13								13	3%
2012	615	40	14	10						64	10%
2013	984	100	88	87	70					345	35%
2014	1133	211	76	44	15	8	6			360	32%
2015	1175	46	41	34	34	23	15	14	13	220	19%
2016	1531	87	69	53	37	25	19	16		306	20%
2017	1537	73	73	71	22					239	16%
2018	1699	74	44	42	35	23	20	15		253	15%
2019	1794	56	51	19	13	13				152	8%
2020	2120	28	25	21						74	3%

In Table 1 we can see that the number of journals published in predator journals rapidly increased from 2013, and gradually decreased from 2018. The number was lowest in 2011, probably because the governmental publication requirements were just adopted that year. The highest number of such articles was published in 2014, reaching at least 35% of all the works. It is worth noting that in 2013 one and the same journal published 100 articles affiliated with Kazakhstan, and in 2014 another journal published 211 articles by our authors. If a journal is delisted in about 3-4 years-time, then the decrease in the number of articles from 2018 might be temporary. Moreover, the results given in the table are based on the top 10 source titles in the search.

We subtracted the minimum number of articles in delisted journals from total number of articles, and have got the approximate maximum number of articles journals with ongoing indexation (See Table 2). We can assume that this number has increased steadily year by year, and grew four times in 2020 in comparison with 2011.

TABLE II. The Approximate Number of Articles in Journal with Ongoing Indexation

Year	Total number of articles(A)	Minimum number of articles in delisted journals (B)	Maximum number of articles in journals with ongoing indexation (A-B)
2011	513	13	500
2012	615	64	551
2013	984	345	639
2014	1133	360	773
2015	1175	220	955
2016	1531	306	1225
2017	1537	239	1298
2018	1699	253	1446
2019	1794	152	1642
2020	2120	74	2046

3. Specific Investigation of Predator Publishing

To make our assumptions more exact, we have also searched for the list of the people awarded the PhD degree. Unfortunately, there wasn't a common list for the whole Republic, but the separate lists of dissertation councils acting as an awarding body. According to the information of two dissertation councils 'Philology' and 'Linguistics', 31 students have been awarded the PhD degree since 2019 [9]. In Table 3 you can see which journals they published their obligatory Scopus articles in:

TABLE III. Number of PhD Holders with an Article in the Journal

№	Name of the journal	Number of PhD holders with an article in the journal
1	Opción	12
2	Man in India	5
3	Journal of Language and Literature	3
4	Astra Salvensis	4
5	Voprosi onomastiki	1
6	Przegląd Wschodnioeuropejski	3
7	Journal of Intellectual Disability – Diagnosis and Treatment	1
8	Space and Culture, India	1
9	Voprosy Kognitivnoy Lingvistiki	1
	Total in delisted journals	25 (80.6%)
	Total with ongoing indexation	6 (19.3%)

In the Table 3 we have italicized the journals that have been discontinued from the database according to data on Scopus website. As we can see, almost 81% of students have been able to publish their articles in predator journals. As a matter of fact, one can apply for PhD defense in

case the article appeared in the journal before the indexation discontinues. And only 19.3% of students worked with quality journals. Checking the citation index of those articles have proved that none of the articles of the PhD holders above have actually been cited so far. It is worth noting, that the predator journals usually tend to be multidisciplinary, accepting any articles in any subfields of a specific field, for example *Opción* or *Astra Salvensis*. The articles with ongoing indexation are mostly published in very specific journals. It means that Kazakhstani scholars might have written good articles, but have not been able to choose the relevant journal.

4. Conclusion

Having analyzed the data above, we have concluded that the number of high quality articles in high quality journals rapidly increased in the period from 2011 to 2020. However, the separate fields need more detailed investigation. Nevertheless, the governmental acts lead to huge expenses on publishing agencies, and increasing the anti-image of Kazakhstan in the global scientific community.

What solutions can we propose? As we can see from the above data, scholars are eager to publish in the Scopus database, not in the journal that corresponds to their research topic. We suggest that restricting the scholars to specific databases like Scopus or Web of Science restrict their choice of journal. If the Ministry required publishing in high quality peer-reviewed journal, then, in our opinion, the scholars would start searching for high quality journals, and would not become the victims of predators, as they would understand that most journals are free of charge. This is a normal practice in most western counties the level of which the Kazakhstani science aims to get at [10].

For example, some high quality journals might not be included in Scopus due to being very specific, or having low citation index because of having few editions a year. So, accepting publications in journals indexed in databases like ERIH, EBSCO, etc. would serve the purpose better. And finally, the Ministry should consider prolonging the number of years of study because publishing in high quality journals takes significantly long time.

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EDUCATION SERVICE DIGITALIZATION: LESSONS OF THE PANDEMIC COVID-19

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Abstract: *The digitalization of education began several decades ago. Distance education (or eLearning) is a result of it. The eLearning's advantages and disadvantages have been repeatedly described in scientific research. ELearning had both adherents and skeptics. And only the Covid-19 pandemic was able to clearly demonstrate all the pros and cons of such education. In addition, it showed the failures and achievements of eLearning, exposing strategically correct and incorrect decisions made by a country's leadership. The impact of the pandemic on the education system is enormous. Results of such influence will be felt for more than one decade after mankind's release from quarantine. However, already now we can assess the important components of the educational process that affect the education level of the population, and the changes necessary to improve the student's competence level. The article is a literary overview of the main challenges, influences, and opportunities that the education system has faced and will continue to face from the global pandemic.*

Keywords: education service, eLearning, COVID-19, pandemic, teaching

1. Introduction

The last year has been characterized by significant changes in people's daily habits and lives. All usual things have been considered as something familiar and unchanging, and now they have acquired a different meaning and a different sound. The possibility of free travel in the world, free movement in own country, the opportunity to meet with friends and colleagues, attending social and public events, visiting cultural institutions, etc. have significant limitations. Society is locked in the own space with a tight social circle interaction. The latest is the most serious challenge to humanity.

On the other hand, the pandemic period gave an impulse to the development of those areas of human activity and technologies that in the pre-pandemic period were either poorly developed or weren't considered at all as promising, for example, services (delivery) and information and communication technologies widespread use in various fields. Especially among the latter, the technologies are being developed for sharing and organizing collaborative activities in the network, as well as cloud service technologies [1].

It is not the first year that society has been moving towards digitalization, and more and more digital technologies are entering our lives. Before the pandemic, the effect of the digital technologies' widespread use was estimated based on partly practical (in certain areas) and scientific results. These results differed and depended on many factors, including the adopted digitalization policy in the country and networks' development. The pandemic made it possible to evaluate in practice the strategic decisions made on countries' development in the context of digital technologies use and the effect of their implementation.

Assessing the digital technologies' impact on various human activity fields is a complex problem that requires data and time for solving, especially when the impact evaluation in the long term.

However, now it is possible to draw certain conclusions based on the one-year experience of existence in the “complete digital world”. The paper pays attention to the digitalization impact on education services.

2. Objectives of the Study

The target of the paper is to evaluate the pandemic time on education services. What are the main challenges education service has received in this period? What are the pandemic impacts on the education services? What are the opportunities the education services gain from the situation? How can we use these opportunities for educational services change?

3. Research Methods

The questions, that are indicated in Chapter 2, describe the global problems and influences. The answers can be received for decades after the pandemic will be finished. Now, we only collect data and try to find dependencies and influences between them. However, the world organizations and the representatives of the global or big corporations have more possibilities for the collection of data, and the first results can be received using their resources.

The literature review approach of the official statistics and information of the world organizations, for instance, the World Bank, UNESCO, UN were chosen. It was not an attempt to assess the influence for each country or compare results between countries. It is the attempt to find the general tendencies and directions that can be changed in the education service in the future under influencing the pandemic based on the official statistics.

4. Main Challenges

The digital technologies used in education are nothing new. Over the past 20-25 years, eLearning teaching methods that operate on online learning platforms have been developing and being introduced. Such methods using, learning allows students to expand their circle, makes it possible to study for people with health problems who are not able to attend educational institutions, allows students to take courses in various universities around the world, thereby increasing their competence, etc. The information and communication technologies using made it possible to expand the student's campus, attract professors from any country in the world to deliver lectures or entire courses. All of the above benefits have long been known and widely advertised in the education system. But eLearning often was used as an addition to face-to-face learning, as advanced opportunities. In the school education system, eLearning is used to organize learning playful forms but mainly as additional functions for students.

eLearning learning as an independent form of providing educational services was used less frequently. It is seen as an opportunity to reduce training costs as well as reduce stress in the socialization context in a new country. It allows expanding the students' circle.

The COVID-19 pandemic has brought about a change in the understanding, application, and use of digital technologies in education services. Over the past year, from March 2020 to April 2021, the world education services have been in a state of challenges overcoming.

According to the UNESCO website statistics [2], 84% of students worldwide in March 2020 did not receive educational services through educational institutions closing. The learning process suspension, permanent and/or temporary, has been going on for almost a year. Today the statistics have improved. However, 10% of all students in the world continue to be without educational services on the 30th of April 2021. "Closures of schools and other learning spaces have impacted

94 percent of the world's student population, up to 99 percent in low and lower-middle-income countries" [3].

The main challenges, strange as it seems, are associated with technology. The world situation analysis showed the following. Countries with low or medium-income suffered the most from the absence or low of communication network development. According to a UNESCO report in the second quarter of 2020, 86% of students in low-income countries were left without educational services through school closings, while the percentage was only 20% in high-income countries.

In high-income countries, students' own computers and high-speed Internet connections. At the same time, students in low-income countries are practically deprived of such an opportunity. Indeed, COVID-19 has exposed the digital gap in education. Ensuring equitable access to learning based on information and communication technology (ICT) is the main challenge. The students from low-income families tend to have limited access to computers and other devices outside of school. In some cases, they live in areas with no electricity and no or poor internet access. According to ITU data, 93 percent of the world's population has access to mobile broadband services (3G or higher), yet 3.6 billion people still do not have an Internet connection [4].

Teaching and learning in an online learning management system as a base learning environment was the next challenge. The complexity was not only by the technology used but also by the pedagogical strategies transformation and teaching materials for eLearning. Experience has shown that most teachers often do not have the experience to "... fully aware of the difference between emergency remote teaching and planned and organized online learning" [5]. "When schools close, especially unexpectedly and for unknown durations, teachers are often unsure of their obligations and how to maintain connections with students to support learning. Transitions to distance learning platforms tend to be messy and frustrating, even in the best circumstances" [6]. Moving learning from classrooms to homes at scale and in a hurry presents enormous challenges, both human and technical. During the first few months, the world experience has shown that training was either suspended altogether or was conducted at a low level, using digital technologies most often as tools for sending educational materials, and not as tools for the educational services provided. And only by the beginning of the next academic year (2021 - 2022) teachers began to use online learning platforms and online learning management systems more widely for teaching and providing a full range of educational services [7].

Note that even at the beginning of 2021, according to UNESCO and the World Bank, postal and radio services are still used as eLearning technologies in countries with low income [8].

For students, fully eLearning without the teachers' support also proved to be a challenge. As shown by a students' survey of different ages from different countries, conducted by UNESCO, the main problem was to learn independently to study in an online learning platform and overcome social isolation [9].

Statistics show that 97% of students drop out of eLearning courses before reaching graduation. The statistics differ depending on the goal. If obtaining a successful completion certificate of the course gives a student something in his/her current job (for example, promotion), or when a student is credited with credits for an eLearning course at his university, the students' number who reach the course's finish is less than 50%. The indicator drops to 5-15% or to 3% for some cases. It takes place if this is a course for which no student credits are accrued or if this is a course that a person chooses simply for himself based on personal interests [10 - 13]. One of the main components of such statistics is the low or absent social component of education. "Schools are hubs of social activity and human interaction. When schools close, many children and youth miss out of on social contact that is essential to learning and development" [6].

Today, more active projects have already turned their heads towards the student, as a person, his/her tasks, and the learning process characteristics. Daphne Koller, the co-founder of online education giant Coursera, is no longer on the project. She and her husband founded a startup Engageli, which aims to replicate the social feeling of being in a classroom. Although "Research suggests that online learning has been shown to increase retention of information, and take less time ..." [14], the social component remains one of the most important for students, and the student's lower age, the higher its influence. In his speech at the global meeting of education ministers to ensure learning continuity, A. Azoulay, UNESCO Director-General, noted that "...The third is that no screen can ever replace a teacher" [15].

Another challenge was an equipped study space presence in the home ensured silence and focus on study. The home conditions were not adequate to provide students with the necessary learning space very often, even in high-income countries [16].

5. Main Impacts

In addition to the challenges, the COVID-19 pandemic has had huge impacts on the education service. These impacts have both positive and negative influences.

The information-communication technologies implementation can be considered as a positive impact. "Even before COVID-19, there was already high growth and adoption in education technology, with global EdTech investments reaching US\$18.66 billion in 2019 and the overall market for online education projected to reach \$350 Billion by 2025. Whether it is language apps, virtual tutoring, video conferencing tools, or online learning software, there has been a significant surge in usage since COVID-19» [14].

First of all, this is the introduction and widespread of online learning platforms. If before the pandemic they were an additional learning opportunity, they became necessary during the pandemic. The pandemic has boosted such technologies using, and IT companies have begun to provide free access. In addition, companies have started to develop new online learning platforms. The number of users of such platforms has been increased. For example, in Wuhan, the number of users increased by 81% [14].

"Nevertheless, the effectiveness of online learning varies amongst age groups. The general consensus on children, especially younger ones, is that a structured environment is required, because kids are more easily distracted. To get the full benefit of online learning, there needs to be a concerted effort to provide this structure and go beyond replicating a physical class/lecture through video capabilities, instead, using a range of collaboration tools and engagement methods that promote "inclusion, personalization and intelligence" [14].

Secondly, this is information and communication technologies introduction for collaboration in the digital space to organize the educational process close to face-to-face learning. Such technologies make it possible to transfer a traditional educational process in a virtual environment. Virtual classrooms, organize virtual students learning groups, and completing project assignments became possible in a virtual environment.

Thirdly, this is the playful educational technologies introduction that makes the online learning process addictive and fun, especially for young children. In addition, such technologies enable the creation of virtual labs for safely building practice skills.

The negative can be considered the next impacts. "The disruptions caused by COVID-19 to everyday life meant that as many as 40 million children worldwide have missed out on early childhood education in their critical pre-school year" [3]. The students from universities and high

school can already organize their time and understood the importance of self-management and self-study. The students from kindergartens and primary and/or middle schools need support and help in self-management and self-study, where the eLearning cannot be able to help always. For example, UNESCO estimates that “Nearly half of the world's students continue to experience partial or complete school closures, and more than 100 million children will fall below the minimum reading proficiency as a result of the pandemic” [15].

At the global meeting of education ministers to ensure learning continuity, the Director-General of the World Health Organization Tedros Adhanom Ghebreyesus warned that “without universal access to education.... inequality, which was further exacerbated during the pandemic, will continue to grow” [15].

More than decades should be need to return to a pre-pandemic trajectory [17]. In addition, if the pandemic is prolonged, we can loss a generation of educated population, especially, if the educational institutions will be closed.

Teaching children in distance mode, especially those of kindergarten and primary school age, requires the attention of not only educators but also parents. When schools are open, teachers promote that children achieve mastery of course in the classroom, but in eLearning, courses mastering is possible only with the parents' helping. The parents were not ready for this kind of work. It is especially difficult for parents with a low level of education. Moreover, work continuing, parents have limited resources to help their children master course. Thus, the education level declines.

According to the UN assess “The learning loss, in the short and long term, is expected to be great. Researchers in Canada estimate that the socio-economic skills gap could increase by more than 30 per cent due to the pandemic. The World Bank identifies three possible scenarios for the loss of learning: a reduction in average learning levels for all students, a widening of the distribution of learning achievements due to highly unequal effects of the crisis on various populations, or a significant increase of students with very low level of achievement due in part to massive dropouts. This suggests 25 per cent more students may fall below a baseline level of proficiency needed to participate effectively and productively in society, and in future learning, a result of the school closures only. In the foundational years of education, the impact might be the strongest. Simulations on developing countries participating in the Programme for International Student Assessment (PISA) suggest that without remediation, a loss of learning by one-third (equivalent to a three-month school closure) during Grade 3 might result in 72 per cent of students falling so far behind that by Grade 10 they will have dropped out or will not be able to learn anything in school. The economic loss might reach \$16,000 of lost earnings over a student’s lifetime, translating over time into \$10 trillion of lost earnings globally” [3].

6. Main Opportunities

The pandemic has exposed not only the problems of the education service and provoked challenges. It also made it possible to assess the impact and level of information technology use in the education service from various angles.

First of all, the pandemic showed the existence of a significant digital gap between countries. This gap is reflected in the high-speed Internet connections and the hardware availabilities for eLearning use in different countries. Internet development strategies in the pre-pandemic period were mainly focused on the short and medium-term. However, the pandemic has highlighted that they should be revised in the context of long-term prospects. According to Jane Coffin, Senior Vice President, Internet Growth of the Internet Society, the fundamental importance for this goal achievement is decreasing the connection gap. Now it is 49%. She issued a joint call to action to

close the global connectivity gap to 20 percent by 2030. According to Stephen Spengler, Chief Executive Officer of the IntelSat, noted that the technology already exists to connect everyone in the world to the Internet. According to his words, now only the Political will absence is a single reason for working together and achieve the goal [18].

Overcoming declining educational level can be addressed through the remedial classes provision and catch up in gap strategies. However, according to new data from a joint study by UNESCO and UNICEF, only a quarter of students have access to such remedial education [17].

eLearning has also demonstrated its strengths and weaknesses. Depending on the subject area, the unambiguous transfer of the face-to-face education to the eLearning has not always proved to be effective. Although research shows that “For those who do have access to the right technology, there is evidence that learning online can be more effective in a number of ways. Some research shows that on average, students retain 25-60% more material when learning online compared to only 8-10% in a classroom. This is mostly due to the students being able to learn faster online; e-learning requires 40-60% less time to learn than in a traditional classroom setting because students can learn at their own pace, going back and re-reading, skipping, or accelerating through concepts as they choose” [14]. On the other hand, digitalization shifts the teaching focus from the study position to seeking and forming knowledge based on critical thinking and adaptability. The pandemic has given educators the possibility to rethink traditional teaching methods and shift them towards new approaches. Those who took advantage of this opportunity want to “...make an e-learning part of their 'new normal' after experiencing the benefits first-hand” [14], [19] and invite others to follow their experience.

Major world events are a driver for change and an impulse for innovation. The pandemic has shown that knowledge must spread at all levels, among people in all countries, across physical boundaries. Achieving these results are based on the improvement of technological and pedagogical components of the learning process. And this can become one of the essential opportunities for educational service development and rethink in the post-pandemic period. “Collectively, we have the time and space to imagine what we would like education to look like [20].

The pandemic has exposed the problem of the teachers' training in modern technologies use. The rapid transition to eLearning faced the lack of teachers' preparation both the technical and pedagogical levels. The teaching profession and their need for better training in new methods of education delivery need in well support.

7. Conclusion

We are so accustomed to open borders and opportunities that, until last year, we could not imagine that this opportunity could be deprived. It seemed to us that digital technologies would help us in any situation and solve all problems. But life has shown the other side of the coin. The widespread adoption of digital technologies does not yet indicate the ability of their use. Replicating pedagogical methods to another environment does not mean their effectiveness. The absence of a teacher does not speak of the student's self-awareness. Parents assessed and recognized the hard teacher's work. Our vast opportunities are not always endless, and it is necessary to learn how to manage them to improve own competence.

According to Kendra Thornton, HundrED Ambassador, United States, “I am hopeful this crisis will show everyone the importance of moving learning experiences beyond the traditional school building and hours, resulting in more real-world application of content and increasing frequency of authentic experiences for students” [20].

The pandemic impact on the education service has been enormous. And we will feel the results for more than one decade. Already, the UN is identifying the following problems that we have to solve soon "...focus on addressing learning losses and preventing dropouts, particularly of marginalized groups; offer skills for employability programs; support the teaching profession and teachers' readiness; expand the definition of the right to education to include connectivity; remove barriers to connectivity; strengthen data and monitoring of learning; strengthen the articulation and flexibility across levels and types of education and training..." [3].

However, overcoming and solving problems give the impulse to the emergence of new approaches, methods, and practices that lead to improvements. The world around us is changing, and it is necessary to change approaches to learning, leaving the best of the face-to-face teaching and introducing the best of modern approaches, thereby increasing the level of service delivery, which contributes to the development of the individual, the country and the world around. Education does not give instant results. Its results are aimed at a long-term perspective. It is important that the focus is chosen correctly and supported by the necessary methods and approaches at all levels, from the government to the technological base.

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SAFE EXAM BROWSER FOR E-ASSESSMENT IN LEARNING MANAGEMENT SYSTEM

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Abstract: *Due to the COVID-19, we have seen overwhelming changes in social interaction and the structure of the education sector. Many universities were not prepared for online learning, and they had to switch to e-learning platforms. However, students and teachers must adjust and interact with the evolving e-learning platforms. One of the crucial problems for e-learning platforms is to conduct secure online exams with very low possibility of dishonesty. In department of Informatics, we investigated an emerging environment which can be used for Bring Your Own Device BYOD scenario. The main idea is to restrict the students to the online exam and then they can have full access to their device once they are done with the exam. The students have no prospect to use the internet, hard drive or any other source of information during the test. The Safe exam Browser operates independently of operating system and unable to make any program modifications.*

Keywords: Safe Exam Browsers, web browser, e-assessments, learning management system (LMS), secure exam

1. Introduction

The covid pandemic increased the demand for digital assessments in the education sector. For the case of assignments, many Learning Management Systems (LMS) are already in place. A learning management system is software application for delivery of educational courses and training programs. However, for the online exams especially in the Computer Science department at FH Dortmund, the majority are being done with pen and paper and then submitted onto LMS. Frank M. LoSchiavo and Mark A. Shatz [1] conducted the research to assess the effect of honour code on self-reported dishonesty during online quizzes. In this study, 72.5% of students reported dishonesty on at least one of the 14 quizzes typically with the help of the textbook or the online materials. Chris Piotrowski. and team conducted a research study on students's perceptions on online exams and dishonesty involved with it [2]. The results were that 76% of the students consider that deceit is much easier in online exam compared to the traditional exams at university campus.

Based on the findings, there is a possibility to further investigate the unethical possibilities in digital exams and how we can mitigate them. Christopher's research [3] on on a digital Bring Your Own Device (BYOD) scenario for the online exam involve less infrastructure and a cost-effective digital solution. This type of exam solution acts as a lockdown browser which temporarily transforms the student's devices into secure workstations with limited access. In department of Informatics, we integrated the web browser environment with the learning management system Moodle [4] for conducting the online exam in controlled environment. In addition, further investigation has been done regarding online proctoring.

There are numerous methods which prevent dishonesty in online exams. If there are no exams at all, then the students will not be able to learn properly, and it can have significant impact on their career and achievement. Student's grading is nevertheless an essential part of university education

because it strongly influences student behaviour [5]. The dishonesty risk can be avoided with the help of certain tools with which teacher or supervisor has control.

The cheating detection in an online exam is difficult since the student's environment cannot be controlled, and it involved expensive infrastructure if the university provide electronic devices to the students. As a preventive action to avoid cheating behaviour, Safe Exam Browser show promising results. SEB is a software that prevent deceitful behaviours for the Bring Your Own Device environment [6] and university electronic devices. In order to prevent impersonation, video proctoring is of utmost importance with SEB solution for online exams. However, SEB in university settings with on-site exams is still a good solution without video proctoring.

The Safe Exam Browser is a secured online exam solution which can be integrated with learning management system like Moodle and ILIAS. The SEB has the supervision of the student computer and network activities during the exam.

2. Safe Exam Browser

Regardless of the advantages of online exams, a secure software solution is needed to conduct exams for bigger audiences. In electronic exams, the security requirements must be addressed like confidentiality, privacy, integrity, authenticity, and availability [7]. The security requirements are addressed with the encryption of data and continuous monitoring of the IT infrastructure. To overcome shortcomings of conducting an online exam, secure exam solution has been implemented in Department of Informatics.

Safe Exam Browser is a browser through which e-assessments can be done safely. The software transforms any student's computer for the time being into a secure workstation. The SEB has the capability to control access to the system functions, applications and any unapproved resources during an exam. SEB runs on a student's workstation, and it is integrated with learning management system (LMS). SEB has compatibility with many learning management systems (LMS) like Moodle, ILIAS, OpenOLAT and Inpera Assessment.

The SEB main architecture consists of two parts: kiosk application and a browser, which is operational on an examination electronic device. Kiosk software is a user interface software which enveloped the system, so it prevents the user activities on the device beyond the specified limit. The kiosk application lock down the system functions [8], and the browser part has the internet connectivity with the online exam from an LMS running on a server.

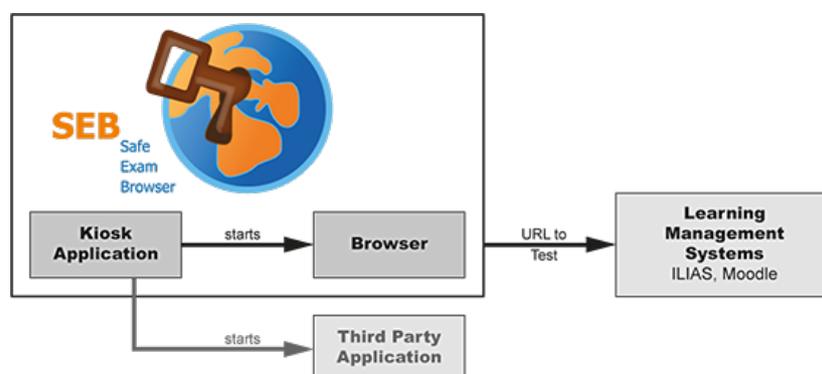


Fig.1. Online exam with Safe Exam Browser and Learning Management System [8]

As previously discussed, SEB makes a locked-down environment with limitations on the browser. The LMS containing the exam opens in full screen window with restricted options for example time and date. SEB also can detect if it is running on virtual machine or virtual desktop infrastructure and enable or disable third party applications like Zoom or Webex.

When SEB is operational, it further prevents the students to use shortcut keys which can terminate or open an application inside SEB. Similarly, students will not be able to access the security screen and login with other accounts. SEB examine the processes and blocks any new process started during the exam. If a student is not performing any task in exam, the screen will not go to sleep mode. The teachers have the possibility to configure an exam with the configuration tool, where security elements like third party applications can be enabled or disabled inside SEB.

The GUI configuration tool is for the administrators and teachers to configure and then securely share with the students. For further protection, the browser exam key can be created with configuration tool settings. Learning management system uses the exam key to verify if the configuration and software version has not been altered.

3. Learning Management System - Moodle

In this work, the Safe Exam Browser is integrated with Moodle LMS. Moodle is a learning management platform that is created to support administrators and learners with a single robust, secure and integrated structure to provide personalized learning experience [9]. Moodle is an open-source learning platform, which acts as a learning management system LMS [10]. In FH Dortmund, Moodle is hosted on dedicated Linux Virtual Machine using Apache, MariaDB and PHP server scripting language. [11]

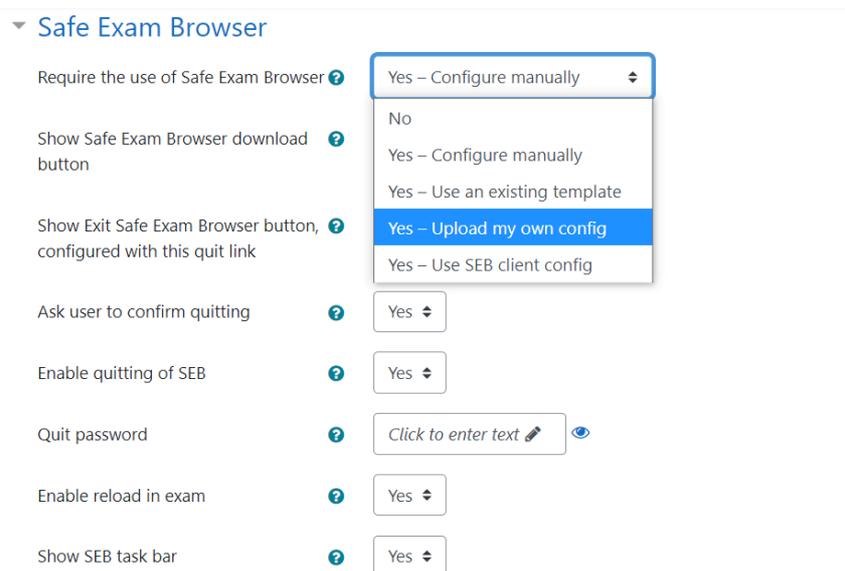


Fig. 2. Safe Exam Browser Settings in Moodle

Moodle has features of creating online tests and quizzes, using various question types. Question type can be multiple choice, true/false, numerical, drag and drop, and embedded. Multiple exams were created to test Moodle integration with Safe Exam Browser and evaluate the suitable question types for the Department of Informatics. The Safe Exam Browser plug-in was installed specifically for the online exams. With the help of the plugin, SEB establishes a secure exam, which can only be accessed when exam key and configuration are correct. SEB configuration can

be done with two methods, one with the Moodle SEB plugin where we can do basic configuration and with the SEB config tool in which we can enable or disable additional features.

4. Digital Exam Solution in Practice

In this work, Safe Exam Browser was integrated with Moodle online exams to check whether it will serve the purpose for a digital exam solution at FH Dortmund. Multiple online exams were tested with different scenarios of SEB configuration. While creating an exam in Moodle, there is an option if the students be able to attempt the quiz using the Safe Exam Browser or not. The administrators can choose this choice according to requirement.

The SEB can be configured manually or with the predefined template managed by the administrator. This way configuration can be uploaded directly in SEB plugin or shared with the students as client config file. SEB configuration template can be used if ‘use of SEB’ is set to Yes. Since there is a need to install SEB client version on BYOD, ‘Safe Exam Browser download button’ was enabled for the students. In order to limit the student’s activity and not let them exit the SEB, the ‘Show Exit Safe Exam Browser button’ was configured with the quit URL link along with the password.

The image shows a configuration form for SEB. It includes the following fields and options:

- Start URL:
- Administrator password:
- Confirm administrator password:
- Allow user to quit SEB
- Quit/unlock password:
- Confirm quit/unlock password:

Fig. 3. SEB administrator configuration and exit password protection

As show in the fig. 3, we can enable the shortcut key for quitting Ctrl-Q instead of a URL link and it will serve the same purpose. In order to protect the online exam against reloading, configurations were changed to disable the reload along with its shortcut key. Similarly, task bar and browser tool bar were also removed so the student’s will not be able to open any other application inside SEB. Task and browser tool bar visibility is dependent on the administrator and can be allowed. For online exams, time and date are necessary for students so it was allowed. The keyboard layout was set to ‘Yes’ to choose between German or English keyboard layout as per student’s need.

The Wi-Fi control can be set to ‘Yes’ so students can choose a different Wi-Fi. The features like audio control, mute on startup, spelling check can be enabled as well based on exam requirement. In order to test some of the website’s access during exam, URL filtering was enabled in Safe Exam Browser to allow certain websites and there were no issues related with it.

Once the configuration and setup complete, browser keys can be inserted to access the online exam. Students will access the config file, start the SEB, and complete the online test with limited access provided by the administrator. For third party applications, Webex and Zoom were tested for online proctoring – a teacher or supervisor can see the students and monitor their behavior and verify student’s identification as well.

SEB developed as an Open-Source Software, is being continuously being improved and online proctoring is one of the important features in progress. SEB was successfully used to conduct digital exams in the controlled environment. The SEB digital exam solution has scalability and reliability with more features to come.

5. Results and Conclusion

The Safe Exam Browser was tested for multiple scenarios and configuration, and it has shown promising results. One of the exams from the student’s perspective can be seen in Fig. 4.

Summary of your previous attempts

Attempt	State	Review
Preview	In progress	

The config key or browser exam keys could not be validated. Please ensure you are using the Safe Exam Browser with correct configuration file.

Download Safe Exam Browser

Launch Safe Exam Browser

Download configuration

Back to the course

Fig. 4. Online Exam integrated with SEB – Student’s view

In the Fig.4, we can see that students have the option to launch the browser directly or download the configuration. Based on the configuration file, third party applications can be allowed. Battery status, voice control, time and date are also provided at the taskbar so there are no issues during the exam. Once the quiz will be finished, students can quit the SEB by verifying with a password provided by invigilator. Online proctoring was tested via Zoom, and it worked in some test cases, however it opens additional issues like chat feature. It requires further investigation and for future work, the study will continue.

Following features have been tested in online exam:

- 1) The SEB browser without URL, search area, navigation and reload.
- 2) The Safe Exam Browser cannot be shut down until the online exam is submitted.
- 3) The third-party application for example Webex has been tested inside SEB during exam.
- 4) Shortcut keys for instance, Alt+Tab, Ctrl+Alt+Del, Alt+F4, Cmd+Tab are disabled.
- 5) The option of taking screen shots is not possible during exam.
- 6) Web pages can be configured and accessible during an online exam, using URL filtering.
- 7) Spell checker and dictionary can be enabled or disable as per requirement.

In order to test the security of SEB, administrator password protection has been tested and configuration file remained safe. However, when establishing a cryptographic identity or setting password, Moodle cannot accept the configuration file. Exam browser key protection was tested successfully with implementation of the checksum in the key-file. If a student tries to change the configuration to remove the restrictions, the checksum will automatically change, and Safe Exam Browser will not initialize the exam in that case.

The third-party applications such as Skype, Zoom, Webex etc. can be enabled during exam but since these applications have their own messaging feature, further investigation needs to be done to make sure online proctoring can work at its optimal. Online exams using SEB save money as it is open source and saves time with better security. It is essential to mitigate the shortcomings which have been found related to configurations and future work will be related to discovering vulnerabilities by analyzing the code analysis and testing. In department of informatics, further testing will be done in a more real-life setting, which may further introduce new challenges to mitigate.

An online exam environ has been created in FH Dortmund, which ensures online exams securely with the student's electronic devices. Due to lockdown browser, students cannot access local applications or program during the exam. The SEB works independently to the operating system and does not create any new processes. This new methods for online testing will improve the current and traditional concept of exams. Due to pandemic, we have seen that the traditional methods of student's assessment do not fit the modern requirements. SEB will provide security as well as new ways to assess digital exams for the future.

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QUALITY MANAGEMENT IN A HOLISTIC CARE PLATFORM

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Abstract: *Nursing care is a complex market offered by many different providers. In the development to create a holistic care platform that should meet certain quality standards. The question is, how quality can be ensured online for services offered both by self-employed persons and companies. To answer this question, subject matter experts were asked about quality insurance in the care sector and what opportunities and risks exist.*

Keywords: quality management, holistic care platform, expert-interviews

1. Introduction

In the context of demographic change and the shortage of skilled nursing staff in many countries, solutions are needed to efficiently allocate the limited resources in the health and care sector [1]. Current studies indicate that an expansion of outpatient care in people's own homes is not only preferred by a large proportion of older people [2] but could also be associated with considerable cost savings for long-term care insurers, local authorities, and - with appropriate pay-as-you-go procedures - for the people in need of care and their relatives themselves compared with inpatient accommodation [2]. To provide holistic care in the patient's own home, a network of different service providers is usually required. This can consist of family members, neighbors, volunteers, but also, for example, professional care providers and service providers for low-threshold services. Also, depending on the type of support needed, it may make sense to use technical assistance systems such as fall sensors, reminder functions, voice assistants, etc [3].

The results were generated by the interdisciplinary research project Smart Care Service, which is funded by the EU and the state of North Rhine-Westphalia (EFRE.NRW). As part of the research project, a holistic care platform is to be developed. With the help of the platform, bottlenecks in nursing staff are to be minimized through the efficient use of resources. A platform solution will be developed that brings people in need of care together with available providers in their vicinity in a timely and flexible manner.

The platform is intended to offer added value both for people in need of care and their relatives and for the providers who offer their products and services via the platform. In the area of professional care, the platform is intended to help relieve the burden on caregivers so that they can focus more on the interpersonal, social aspects of care. The question that arose from the project is how to ensure the quality of the work offered on the platform. Experts were interviewed, whose ideas can be read following the methodology section in Chapter 3.

During the interviews, it became clear that the experts have different opinions on how and whether quality in the care sector can be objectively assessed, and the difficulty became clear of how self-employed caregivers can offer themselves on a holistic care platform and at the same time ensure the platform provides good quality. To address this question, the methodology will be presented below. After that, the experts' implementation ideas will be highlighted and clarified, and a summary of the results will be provided.

There are related publications on the subject by Loureiro et al. [4] who evaluated a web-based platform for quality management in geriatric care. Furthermore, Fürstenau et al. [5] examine platform business models, which are based on a lack of knowledge, that enable individualized coordination of care for patients with rare diseases and explores the question of how the quality of care and information can be ensured in rare diseases on a platform. In addition, Martins et al. [6] write about technological solutions and the role in healthcare, and their implementation in the social care sector. They expect good results in terms of quality of care services. The study analyzed the change from typical paper registration to a registration performed through a web-based platform in a Portuguese social care facility.

2. Methodology

To find out how quality can be ensured on such a platform, qualitative guided expert interviews were conducted in 2020. The goal of the external interview was to learn about possible ideas and implementation tools to evaluate the quality of the work. In contrast to standardized interviews, guided interviews are characterized by more openness. This is to contribute to an unbiased approach to the interviewees so that they are encouraged to describe their respective perspectives [7]. In the field of qualitative social research, a distinction is made between a variety of guided interviews, but all of them use the guide as a data collection tool. In the field of guided interview methods, the expert interview was selected as a suitable method against the background of pursuing the research interest. In the context of expert interviews, the experts are not the focus, as is common in most types of interviews, but the interviewees stand as representatives for their field of action or topic [8].

The interview guideline was created and structured according to the SPSS principle of guideline creation by Helfferich [9]. SPSS stands for the German parameters “sammeln” “prüfen”, “sortieren” and “subsummieren” translated into English it means "collecting", "checking", "sorting" and "sub-summing" [10]. This method was used to ensure a certain openness on the one hand, but also to secure a rough framework for conducting the interview. Therefore, numerous first questions and keywords were collected in an open exchange. In a second step, these were screened and, if not suitable, removed from the collection or put on hold. The remaining questions were then sorted according to content aspects and integrated into the common formulation guidelines of the qualitative interview guide. By this is meant that the questions were formulated as openly, generally understandable, and narrative-generating as possible to achieve the greatest possible information gain. Finally, the guide, consisting of 8 categories and a total of 32 questions, was put into its final form. In selecting the sample, care was taken to ensure that the heterogeneity of the research field was represented as much as possible [11].

Due to the limited time frame for the research project, theoretical sampling was not used, and selective sampling was used instead. In selective sampling, criteria are defined in advance based on which the interview partners are to be selected. In the context of this analysis, the experts interviewed should come from as diverse a range of fields as possible and currently be in regular contact with potential users of a care platform or potentially interested in appearing as a provider on a care platform.

The interviews were mainly conducted in person and documented using a dictaphone. All experts agreed to the recording of the interview and therefore signed the data protection declaration prepared for this purpose. A total of 15 experts were interviewed in 2020. The length of the interviews varied between 45 and 90 minutes. The following figure shows the different areas of the groups that were interviewed. People from the field of care services, care and social counseling, health and care insurance funds, housing counseling, voluntary organizations, financial service providers, senior citizens' representatives, and from the field of mail-order pharmacies [12],[13] were interviewed.

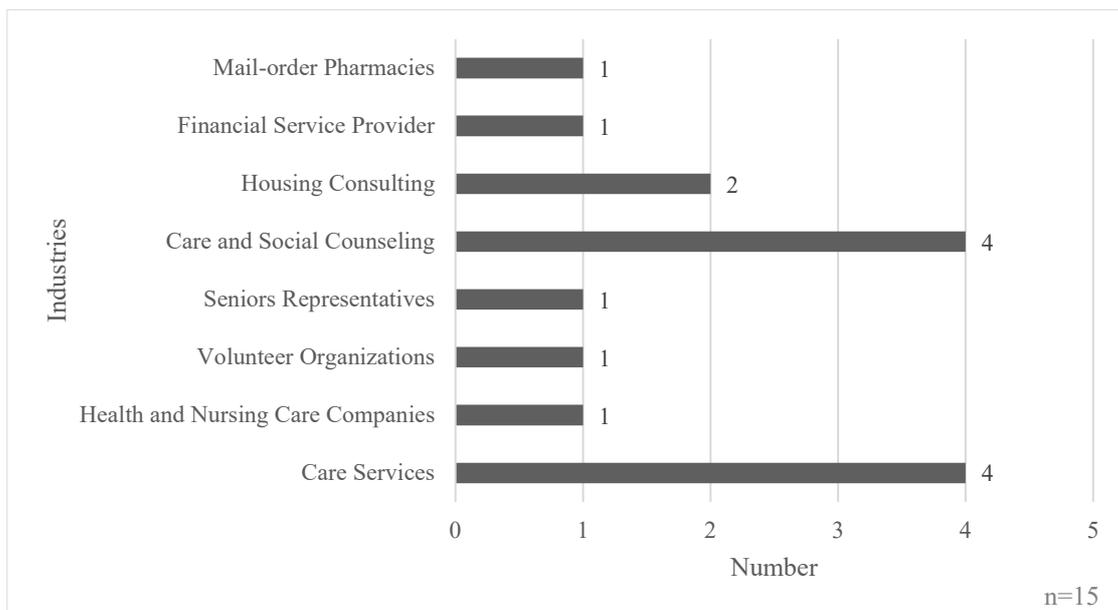


Fig 1. Sample of interviewed experts

Accordingly, the composition of the sample can be described as quite complex. The interviews were analyzed using MAXQDA software. Methodically, the interview material was coded according to the content analysis of Gläser and Laudel [12]. Accordingly, categories were defined a priori based on theoretical preliminary considerations. These were then supplemented with further categories during the evaluation process.

3. Ensuring the Quality of Services on a Care Platform

In industry, quality management has been an integral part of the organization, description, and definition of processes and workflows for decades. Intended as structuring support for defined work processes, quality management, and the safeguarding of quality targets were adopted from industry into the Social Code XI with the introduction of long-term care insurance. The aim is to provide qualified professional care through extensive specifications, regulations, and monitoring instruments. Legal framework conditions and the national expert standards are the basis for our nursing activities. The task of practical quality management is to prepare these basic principles and adapt them to the facility in such a way that the documents and process descriptions created are working support and a working framework for practical nursing care on-site [13]. However, it is important here that quality management is close to practice and the profession to have a real benefit. Within the framework of a care platform, quality management can play a major role. Especially for the initial situation of a care platform on which services of professional care providers as well as of further service providers and products are offered, a special analysis of possible quality assurance options is required. Qualitative expert interviews were conducted for this purpose. The results of the expert interviews gave a good insight into the dimensions of quality management to be considered. The results were therefore classified according to when the quality audit was carried out and the content to be assessed.

3.1 Ensure Quality before Joining the Platform

Demand for services or products, and persons with assistance needs and their families should be able to rely on the fact that the service providers and products offered meet a certain level of quality. Experts say it is difficult to achieve comprehensible standards. The care market is more

of a quantity market than a quality market, but the bad providers do not stay in the market by themselves and the good providers tend to stay. They also only manage to do so through quality. To this end, the experts have had various ideas on how to ensure quality in the nursing sector. The experts' ideas are to be summarized in the following figure.

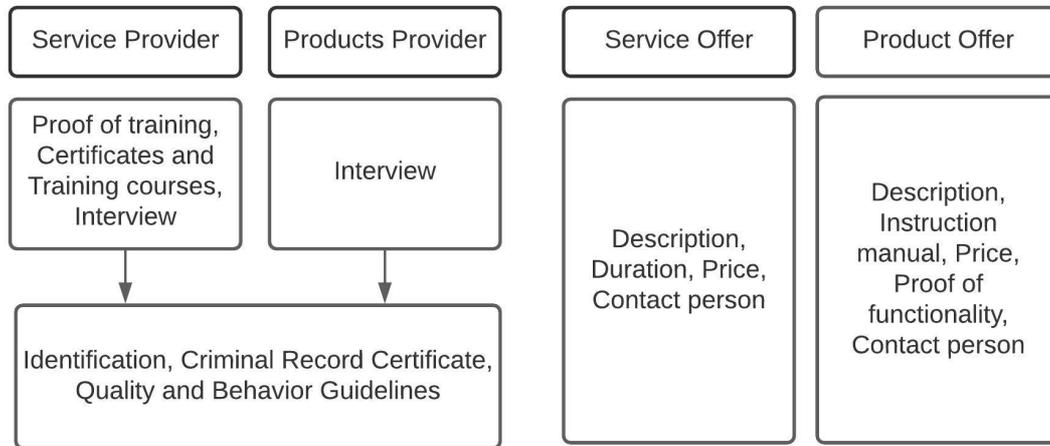


Fig 2. Quality check before inclusion on the platform

Fig 2. shows the possibilities identified from the interviews conducted to check the quality before a provider of a service or product is admitted to the care platform. On the side of the service provider, which can consist of self-employed persons as well as providers from the care, there is the possibility to obtain quality through certain proofs. This can be done on the one hand with a police certificate of good conduct and regular meetings. There is also the possibility to conduct training for the care staff, i.e. qualification measures or quality measures. Staff qualifications can also be checked before entering into a contractual relationship. In the case of projects supported by state funds, it can be assumed that quality assurance is already being carried out there. The services must be described precisely, as well as the duration of the service. In addition, it is important that the prices are transparent and that a contact person is available for queries. For providers of products, it is the same as for providers of services that identification with an ID card and a police clearance certificate is useful, as well as a signed declaration of consent to comply with quality and conduct guidelines. The execution of a personal identification interview can also eliminate initial doubts. The product range to be offered on the platform should be well described. The instructions for operation or installation should be described in a way that is easy to understand. The price information should also be transparent here, as well as proof of functionality (test, certificates, or other test seals). Contact details for a direct contact person can also help here to increase quality and user satisfaction.

However, it also became clear during the interviews that a one-time quality assurance upon inclusion on the platform is not sufficient.

3.2 Ensure Quality after Joining the Platform

Fig. 3, therefore, presents the options for quality assurance of existing providers on the platform that were identified during the interviews.



Fig 3. Quality indicators of registered providers

Service providers can assure quality through various means, as described in fig 3. it can be training for the providers, as well as evaluation possibilities on the platform. the response speed on the platform for questions and queries should be fast. the formal guidelines, such as the minimum wage, must be checked. the set deadlines must be met and in addition, the providers should show up on time for these. The suppliers of the products can be evaluated by verified customers to ensure quality. likewise, the speed of response to concerns is important here. delivery time should be made manageable and transparent, and deadlines should be met. The results of the interviews show the complexity of quality assurance for a care platform. Different time perspectives have to be considered as well as separate criteria for the type of providers and the respective offers have to be defined. On the other hand, the effort for the providers should be kept as low as possible. A good balance has to be found between the benefit and the simplicity on the platform to offer oneself but to keep quality standards.

3.3 Additional Experts Ideas and Challenges

However, there is no ISO certification or similar yet. So it always has to be checked on an individual basis. In some cases, admissions are made through the social welfare office and through the nursing care insurance funds, which look at quality in advance. There is also, for example, a cooperation agreement that you need to be able to settle accounts with a health insurance company, for example. Then certain qualifications and reports must be made. Another idea would be a quality catalog, where people are also personally monitored and accompanied to ensure quality. There is also the Pro.NRW recognition agency and every municipality have something like a recognition organization. Every care service must be recognized there. Measuring the quality of care is an endless topic. Something is being evaluated for outpatient care. It would be desirable to have a benchmark. Somehow the quality of care must be objectified and not be the result of subjective perception. The ability to objectify the quality of the provider for clients would be useful here.

In addition, respondents expressed the following views on quality assurance on a holistic care platform. The target group does not know exactly where to obtain information on technology-assisted living in old age and how and whether this can be financed. There are inquiries from participants who need advice, but of course, also have to look at whether the options can be financed. Here, poverty in old age is also a factor to consider.

Increasing digitization is also a big topic among people. New devices are conquering the market. Technology that makes it possible to live at home longer. This raises the question of the reliability of technical devices and whether they could jeopardize the work of some care services in the future.

Another problem is dumping prices due to an increasing share of technology in care. This happened a few years ago in intensive care in Mecklenburg-Western Pomerania, a state with a small population. One interviewed expert there told us that hourly rates are negotiated individually per customer and no framework agreements are concluded. There, a price between 25 and 30 euros per hour is normal. Then a large provider came and went down with the prices. As a result, all the health insurance companies came to the expert and expected her to go down with the prices as well. The only thing that counted for the health insurance was that the care was guaranteed. Whether it is good or bad does not matter, because it is only the administrator who says, we save costs here, sum X per month. As a result, prices have fallen, sometimes to less than 15 euros. That is why the expert takes a critical view of the development, also concerning technology in care, out of concern for further possible price reductions and quality losses.

3. Results and Conclusion

First, it is a decisive advantage in the care market to rely on quality to establish oneself on the market in the long term. For this reason, an online platform should also be subject to quality assurance. For this, the experts had various ideas on how quality could be ensured. For example, a qualification via training in the care sector could be necessary to offer one's services on the platform, or care should be rated, like google ratings, to comment on people who do not demonstrate the corresponding quality. Another possibility is to interview in advance to get to know the persons and to see whether they are considered trustworthy - besides, a police record can reduce the chance of possible criminal energy. There is no uniform iso guideline or similar yet. However, there are recognition bodies for care services that look at the quality of the service providers in advance. this could also be an indicator, for example, so that service providers can offer themselves on the platform.

One possibility would also be to do a comprehensive test or quality catalog before being allowed to work on the platform. This would possibly ensure that people who are interested in the work are happy to spend the time on it and receive important information. this could take place in addition to an interview.

The experts agreed that it is difficult to measure quality in the field of care. However, the various approaches can be used to obtain as large a portfolio of quality assurance measures as possible and to integrate these in a meaningful way for the smart care service project. moreover, it offers the opportunity to discuss how uniform quality assurance could also be ensured in the field of care and the field of online platforms.

In addition, financial and content-related issues still need to be clarified when using technology-assisted living. Although more and more devices are coming onto the market to make living at home easier, the question of reliability and usefulness is another issue. Here, education on possible financial support as well as benefits would be a crucial contribution. There is also concern that new types of technology and large care providers will lower prices in the long run, as the example in Mecklenburg-Western Pomerania shows. What comes up short here, according to the expert, is quality. Here, in the future, it will also have to be looked at whether low prices are sufficient as the only parameter in a very human-centered environment, or whether quality and time for care are not of greater relevance. However, further research is needed in the area to identify needs-based quality attributes for a holistic care platform.

Further research will be needed to test the results. This work has obtained its results from the expert interviews. There are certainly, however, more quality characteristics and ideas on how to ensure quality in such a holistic care platform. The research to date, nevertheless, shows potentials for platforms and how they can meaningfully contribute to quality enhancement and assurance.

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INDUSTRY 4.0: ROLE OF IOT IN HEALTHCARE

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Abstract: *IoT is a key component of Industry 4.0 which aims to transform industries into efficient, high performance and easily scalable systems. IoT based solutions have revolutionized the healthcare industry by changing the way it used to operate earlier. The purpose of this paper is to study the role of IoT in healthcare systems. This includes a study into the prevalent and ongoing research in IoT based solutions and IoT based products which are already available to users, advantages of upgrading to an IoT based system and challenges of this system.*

Keywords: Industry 4.0, IoT, Healthcare

1. Introduction

Industry 4.0 is a strategic initiative introduced by the German government which supports development of the industrial sector. The goal of this initiative is to maximize industrial manufacturing through digitalization and implementation of new technologies [1]. Some key technologies of industry 4.0 include Cyber Physical Systems (CPS), Internet of Things (IoT), Cloud and Mobile computing and Big Data [2]. Industry 4.0 has numerous benefits such as decrease in production, logistics and management costs, enablement of mass production without increasing production cost, efficient use of natural resources and energy, flexible working environment, and reduced time for market readiness of products [1, 3]. IoT has been widely adopted in a variety of industries including healthcare. There are numerous benefits of using IoT in healthcare which are described in detail in section 3.

2. Application/Services of IoT in Healthcare

There are a variety of IoT based applications, services and proposed architecture and solutions tailored for the healthcare industry, some of which are described in this section:

Remote Health Monitoring: Research conducted in related fields have proved remote monitoring is possible where existing systems remotely monitor objects and collect associated data. This concept can be applied to patients as well through remote health monitoring. The data collected from these patients can then be shared with doctors, hospitals, etc. to facilitate their treatment. Remote Health Monitoring can be used to track health of non-critical patients while they stay at home as well as provide healthcare to people at rural areas which were previously not feasible. With continuous developments and new discoveries, remote health monitoring would help in provisioning healthcare in the future [4].

BSN (Body Sensor Network) - Care: The BSN technology is a collection of lightweight, low-power, wireless sensor nodes which are used to monitor human body functions as well as surrounding environment [5 - 6]. A BSN-Care system is a secure IoT based healthcare system using BSN. This tool consists of wearable and implantable sensors which are integrated with biosensors such as ECG, EMG, EEG, BP, etc. This system collects data, analyses them, and notifies a person if something is wrong, for instance, when BP of a person surpasses the normal level of 120, an immediate alert would be triggered to inform the person about this [5].

AAL (Ambient Assisted Living): AAL is an IoT based platform powered by artificial intelligence which is responsible for healthcare of aged individuals. AAL services provide an independent way of living for the elderly as well as provide them with assistance if necessary [7].

Healthcare Solutions using Smartphone: Using smartphone as an IoT based device to track various health statistics, collect data and analysis of health data provides a low-cost alternative to otherwise expensive medical consultations for many people nowadays [7]. Some examples of smart phone apps for monitoring general health are as follows [7]:

- Health Assistant which monitors body water and fat content, blood pressure, body temperature, etc.
- Google Fit which monitors a user's walking, jogging, running, and cycling activities
- iOximeter which calculates pulse rate
- Eye Care Plus which monitors vision
- OnTrack Diabetes which tracks blood glucose levels
- Heart Rate Monitor which monitors heart rate on real time basis
- Water Your Body which tracks user's water intake
- Finger Print Thermometer which calculates body temperature from fingerprint
- Skin Vision which monitors a user's skin health

Wearable Systems: Wireless Body Area Networks (WBAN) are considered to be an essential component in IoT based healthcare systems. Such a system consists of different types of sensors. Examples of such are described below:

A Pulse Sensor which has been widely researched for medical purposes as well as tracking fitness can be used to detect cardiac arrest, pulmonary embolisms, vasovagal syncope. Wrist sensors are considered to be most suitable for long term usage [8].

Monitoring respiration is useful in identification of a number of respiratory ailments such as asthma, tuberculosis, lung cancer, hyperventilation, obstructions of the airway, apnea, etc [4]. There has been considerable research about development of sensors for measuring respiratory rate. Some examples are, nasal sensor based on a thermistor [9], ECG derived respiration which uses echocardiogram signals to measure respiratory rate [10], fiber optic sensor in an elastic substrate which could measure vibrations caused by respiration [11], stretch sensor [12 - 13].

Measuring body temperature helps to determine hypothermia, heat stroke, fevers, etc [4]. There are several examples of body temperature sensors used in scientific studies. Most common ones are the negative-temperature-coefficient (NTC) type sensor [14 - 15] and the positive-temperature-coefficient (PTC) type sensor [16 - 17]. There are several works which researches the development of a sensor which can be printed on a thin and flexible polymer with an adhesive on the back to attach it directly to human skin [14].

Regularly monitoring blood pressure helps in detecting cardiovascular diseases [4]. Several works have calculated blood pressure by calculating the pulse transit time [18 - 19]. Usually, a chest wearable ECG is required which has a wired connection to other devices [4]. However, one study opted to use PPG sensors to calculate the same [20]. This area remains to be a field of further research.

By measuring pulse oximetry one can calculate how much oxygen has been absorbed in the blood stream [21]. It is helpful in detecting hypoxia [22]. There are different devices used in different scientific studies to determine this metric. Some examples include a portable wearable low-power pulse oximeter [23], an in ear reflective pulse oximeter [24], a wrist worn pulse oximeter [25].

In combating COVID-19: There are various IoT based applications for monitoring the current COVID-19 situation as well as research about possible solutions to prevent further spread. Some examples include drone surveillance to ensure quarantine protocols are being followed, finding the origin of the outbreak and trace its progress, identifying infected persons, ensuring quarantine compliances are maintained and remote monitoring of house quarantined patients [26].

Many MNCs promote IoT-based healthcare and are revolutionizing the way healthcare industries work. Some examples include Apple©, Deutsche Telekom©, Cisco©, Intel©, Google©, Microsoft©, Samsung©. The Memorial Hermann healthcare system is using Apple's solutions to provide effective and more secure healthcare services. Researchers of Deutsche Telekom are mainly focusing on the development of technologies that can make healthcare services personal, local, and digital instead of centralized. Cisco is offering smart applications to improve efficiency without losing security. Microsoft is using an intelligent system to capture health data from devices and extract important information from gathered data [7].

3. Advantages of IoT in Healthcare

With a growing demand for more efficient healthcare solutions, IoT is proving to be a suitable technology. There have been several research studies published in the last few years that describe advantages of IoT in the healthcare industry. This resulted in various smart applications, services, and protocols to provide on-demand health services [27]. Some of the advantages of adopting IoT in healthcare can be classified as follows:

Integration of technologies: IoT in healthcare is nowadays becoming a universal approach to fulfill human needs when used either for health, exercise, safety, or beauty reasons. It facilitates seamless integration of different technologies without concerning its complexity [28].

Data extraction: IoT enables the extraction of useful knowledge from different sources. Once health information has been extracted, it is analyzed. This information is valuable for further treatments [29].

Remote health monitoring: IoT devices allow patients to get their inclusive health information frequently and may alert patients to any abnormal behavior, potentially saving them from serious harm. Many diseases become lethal if they are not treated in a timely manner so with the connected IoT devices and smart alerts doctors can diagnose the illness of their patients in real-time, treat their diseases, and saves lives in case of an emergency [27 - 28].

Cost reduction: IoT innovations can be used to monitor the health status of the patients on their own which reduces unnecessary visits to the doctor, hospitalizations, and diagnostic tests. Also, technological fusion cuts down the cost of an amount that needs to be paid on particular technology usage [28 - 29].

Easy availability of Data: Health history, post-visit orders, and other information are available to patients in real time and from any place. This improves the overall experience for both (patients as well as doctors) [27]. Also, IoT solutions are very easy to use (e.g., Smart wearable devices require few clicks and simple operations) [28, 30].

Efficient healthcare resource management: IoT is useful for the healthcare administration to get valuable information about healthcare equipment and monitor staff performance. It helps to improve diagnostic accuracy and suggests more innovations (e.g., IoT can monitor the equipment that needs to be refilled or calibrated, such as oxygen tanks, and notify staff in such situations) [31].

International collaboration: IoT eHealth ecosystem globally connects health professionals which results in more access to intercontinental facilities for the patients. Also, exchange of the knowledge and experience between medical professionals can lead to more insights into medical research [28].

There are several other advantages of using IoT in healthcare. The techniques like machine learning and data analytics can be integrated to predict the occurrence of diseases like cancers, infections, or heart attacks which can save human life [28]. Apart from this, IoT solutions can be useful to provide safety to healthcare workers or patients. For example, by tracking the movement of staff, patients, and visitors, deviant or threatening behaviour could be warned. Also, expensive, and limited healthcare equipment can be tracked and monitored through IoT for safety purposes [31].

4. Challenges of IoT in Healthcare

IoT is an emerging technology in the healthcare sector [32]. Many scientific studies have been conducted regarding the design and implementation of IoT services in the health sector to solve problems, however there are many challenges as well which needs to be addressed [33]. Some of these challenges are mentioned here:

Security and Privacy: With the rapid adoption of IoT in the healthcare sector, IoT services, and applications demand security from unauthorized authentications [28]. Existing IoT systems are not able to bear security and privacy risks for the enormous health data that are continuously generated from connected sensors. To manage the privacy and security of health data, a secure and effective cybersecurity system is essential [32]. Some common security issues of IoT based solutions include tag cloning, spoofing, RF Jamming, cloud polling, direct connection, Eavesdropping, Sybil attack, Sinkhole attack, Sleep Deprivation attack, Man-in-the-Middle attack, SQL injection, Denial-of-service attack, malicious code injection, Trojan horses, brute-force attacks, etc. Additionally, selection of weak passwords, unauthorized data share and, incorporating used medical devices are a threat to security and privacy. Some of these threats can be mitigated by implementing security measures. Healthcare organizations can further regulate security measures by educating people about the same and by using efficient and adequate security mechanisms [28].

Trust: While transmission of health information from sensors to its origin, there might be possibilities of unwanted malware attacks which can access IoT via the internet and manipulate or corrupt information in between. This in turn causes risk for such information [31].

Also, trust is required to build a compassionate and caring interrelationship between patients, their families, and healthcare workers. For example, nursing has been considered the most honest, ethical profession in the last 14 years because of its trustworthy relationship with patients. Nurses can be more engaged with the technology to know better assessment, surveillance, and treatment for patients and improve patient care [31].

Scalability: In general, IoT in healthcare is all about a large number of interconnected smart objects and communication technologies. So, with the drastic escalation of the connected services and devices, the healthcare system demands more scalable architecture where varieties of devices and systems can integrate seamlessly [33]. To manage device diversity, data volume, communication protocols and performance, there is still a need for a robust, efficient, and standardize framework [30]. Scalability signifies the capability to add new systems or functionalities into existing infrastructure by keeping or increasing their quality [34].

Interoperability: Interoperability is an essential aspect of IoT development and especially more relevant in the healthcare domain. Various investigations and research have been conducted to

maintain interoperability between IoT devices, services, platforms, and data structure but still, it remains a challenging task. IoT devices in healthcare system generate a large amount of data in different formats and the extraction of data from such complex systems is more challenging. To address this issue, interoperability between complex systems must be ensured by the IoT developers and constructors [34 - 35].

5. Results and Conclusion

Various studies and research have been conducted on IoT based solutions to streamline and optimize the healthcare processes and systems. Several studies in this area have proposed different architecture models to develop an efficient healthcare system. Some useful apps of IoT-based devices include AAL, Wearable Systems, Smartphone based health apps, Remote Health Monitoring, etc. As studied in this paper, this system has numerous advantages such as technology integration, data extraction, cost reduction, international collaboration, etc. However, there are plenty of challenges too. These are in terms of security, privacy, scalability, and interoperability. In spite of these challenges, this area remains to be prominent in further studies and research. We believe these IoT-based apps and services are the next step in modernizing the healthcare industry. These challenges can be overcome with proper measures. Many companies are promoting these technologies by incorporating them in their research and development areas.

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A STUDY ON SMART WHEELCHAIRS: IMPROVING THE QUALITY OF USAGE FOR PEOPLE WITH MOBILITY DISABILITIES IN SMART CITIES

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Abstract: *A smart electric wheelchair is an electrically powered wheelchair to which sensors, computers and other assistive frameworks have been attached. For over a decade there have been researches and studies towards this aspect of improving the quality of life. Although there has been little effort to provide a systematic review of smart wheelchairs by researchers, the growth is on par with the other fields of autonomous systems like robotics and automotive engineering. This paper aims to provide an overview about the related research. We chronologically discuss the dawn of smart electric wheelchairs, its journey so far, a glimpse of the current research and finally ending with some suggestive extensions to improve independent mobility for people with mobility disabilities. Emphasis is also given to foreseeable extensive use cases and ways to resolve them with the available and tenable technology. This field can synergistically prosper by borrowing technology from other contemporary engineering disciplines like e.g., machine learning and deep neural networks. We conclude with our vision for the future of this field and how to best support people with mobility impairments with the given solutions.*

Keywords: independent mobility, state, position, orientation, normal distribution transform, model, error, compensator, cruise control, localization, neural networks

1. Introduction

Independent mobility is an important factor for quality of living. In this paper we discuss use cases for smart wheelchairs for people with limited mobility due to aging, disabilities or due to factors such as accidents, chronic ailments and similar. For aging people, independent mobility reduces dependence on caregivers and family members and promotes feelings of self-reliance. Studies often reveal that mobility limitations are one of the causes of functional limitations among adults with an estimated prevalence of 40 per 1000 persons aged 10 to 44 and 188 per 1000 at age 85 and above [1]. Studies and reviews reveal that physical activities can improve functional involvements among adults [2]. Chronic ailments lead to functional limitation among all the ages of people is revealed by few other studies [3]. Mobility difficulties are one of the predictors of activities of daily living (ADL) and instrumental ADL limitations because of the need to move to accomplish many of the daily activities. It is also observed and witnessed by the author during the time of the draft of this paper that amidst the COVID-19 situation, the elders suffered a lot due to social distancing thereby resulting in restricted support from the caregivers due to the possibility of infection. Keeping Mobility as a secondary function, people with disabilities are hugely reliant on caregivers and other medical supporters for the basic needs like eating, drinking, handling items and communicating with others especially in large groups. Intelligent wheelchairs can play an important role in helping them to be more independent and autonomous. This paper aims to improve the intelligence with the help of contemporary research and analysis. In the section 2 we provide a glimpse of the evolution of the SWs and in section 3 we propose some improvements in terms of quality and cost to the works done in engineering a smart wheelchair.

2. Review of Technologies

To make the design universal and to cater to mass production, researchers have used platforms originally developed for mobile robots to support and instill intelligence and smartness to the Powered Wheelchairs (PWs). Authors of [4] have given an immense study on past, present and plausible extensions for technology of Smart Wheelchairs (SWs). A Smart electric wheelchair generally consists of a powered wheelchair to which onboard computers, sensors and other peripherals are mounted. In this research work we will be referring to smart electric wheelchairs as smart wheelchair (SW). The authors of papers [6] – [7] provide structures to typical powered wheelchairs and works [8] – [13] explain the different ways to design smart wheelchairs with the help of the mobile robotic platforms already existing, their evaluation based on the interaction with the user and modular design. Works of Simpson [5] and Ding et al. [14] provide a complete exclusive review of the early trends in the growth of the smart wheelchair following which [4] provides few more steps by exploring in all the available digital databases and more connections to this study. This paper will not extend the recent advances which can be incorporated in Human Machine Interface (HMI) for controlling the smart wheelchair but combines to bring the existing interfaces and together with the navigational sensors for better intelligence with improvements in the cost factors. The current trends in smart wheelchair revolve around the principles of modern autonomous behaviors which have been developed for automobile and robotics. These principles are categorized and presented in the following paragraphs.

Localization and path planning in a combined manner help to identify the position of the wheelchair in an environment and successfully navigate through an optimal or near optimal path by constantly taking inputs from various sensors based on vision, range, global positioning system (GPS) etc. Analogously the medium of aid does not be only a wheelchair but any other aiding system or sub-system also. The works of Graf [15] have been to develop an adaptive guidance system with Robotic walkers being able to perceive and localize themselves in their environment and to guide their user to a target support and enhance the independence of people with mobility constraints. Shiomi et al. [16] have developed a Ubiquitous Network Robot Platform (UNR-PF) [19] based smart wheelchair to enable developers to realize and implement various robotic services applications easily in them. Methods to realize the above robotic services is also addressed by the authors. The authors of UNR-PF design [16] claim that the UNR-PF is better than standard development platform middleware like Robot Operating System (ROS) [17] and Real Time Middleware (RTM) [18] since the later enable control of robotic components and not strongly on the robotic service applications. This can be argued in both the ways as there is a need for the support of coordination between robotic services because it is still difficult to realize a standalone robot than can provide multiple services only by itself and means through which connected robotic systems can be established. But this is not favored by majority of robotic enthusiasts. The popularity and the reach of ROS is a proof for this. Works [20] – [22] have been published based on elderly guidance with use cases pertaining to indoors like nursing homes, elderly homes, shopping malls and other confined spaces. Most of the works mainly deal with the network of the SWs and provide ways to interface them. Research works have been carried out in [23] modelling a ubiquitous cloud-based accessibility support for people of all ages. Works of [24] deal with designing a platoon driving system for a narrow corridor based on Adaptive Cruise Control (ACC) with Modelling Error Compensator. Care takers handling multiple electric wheelchairs and people at the same time, get benefited with this feature. Controlled motion can be established for all the wheelchairs with this technique. Likewise tracking the caregiver also proves to be helpful for the nursing homes and this is presented by another work [25] in which the system tracks and follows the caretakers. The system described in [25] deal with obstacles and carefully tries to avoid them. Intelligence and smartness can also be imparted to the electric wheelchair through autonomous navigation system. Though the works of [26] are not on smart electric wheelchairs, it is worth mentioning that the team had come up with an intelligent walking aid system with functionalities and working principle like the topics of discussions in our case.

Cascading human machine interface with the autonomous behavior so that the user is in control of the situation always makes the user as well as the system smart. Furthermore, machine learning is also being used for recognition with the help of trained models. Wu et al. [27] have designed an uphill controller and propose a ramp detection model implemented using deep learning algorithms. [28] provide an extensive and intensive review and a complete state-of-the-art overview of the research trends for SWs. With introduction of handsfree technology and brain control interfaces [29] where sensors are mounted over the head, obstacles (both static and dynamic) are detected using camera system. The motion of the platform is controlled through brain signals. With the provided study on the available technology, we will be proposing some use cases to improve the smartness of the SWs in section 3.

3. Plausible Annexures and Our Proposals

We would like to claim that all our proposed solutions are mode based, meaning, upon selecting the mode the corresponding functionality will be activated and henceforth followed by SWs. This provides a way to disable the feature when not required.

3.1 Traffic Alert and Road Crossing

Extensive studies have shown the importance of incorporation of intelligence to powered mobility systems during traffic conditions. One such work [30] identifies that there is a significant number of road accidents involving Powered Motor Drives (PMDs) thereby insisting the need for intelligence and smartness for the powered drives. The problem in this case being accidents caused due to misjudgment, ignorance and various other reasons of the wheelchair users and road users. While enumerating the solutions for the stated problem one needs to consider industrial feasibility, bridge to connect with the available technological solutions and economic viability. Considering the stated factors, we have come up with a cross traffic alert system using radar which has been implemented for automobiles and robotics are respectively described in [39] and [40], can be extended to SWs. To identify the situation of road crossing scenario, the system must also be equipped with a visual aid capable of categorizing and classifying the objects in the images to the user desired category. In this case, SWs must be able to access critical situations like traffic signs for appropriate measures. We impart this intelligence of a combined decision of collision avoidance and obeying traffic signals to our subsystem. Works of [32] and [33] provide numerous ways of traffic sign detection using neural networks. [40] provides an approach for autonomous road crossing by pedestrian robots. The prevalent and published works stated in the contents and more guide as to the possibility to incorporate a similar feature for the SWs to enable a safe outdoor travel. Firstly, we propose our system to be modular so that it can be easy to understand as well as implement. Our system comprises of two parts, a tracking and traffic obeying subsystem. The former is responsible for tracking and looking out for moving objects within a safe and the latter is responsible for the signal identification. Primary sensor in the tracking subsystem is the radar and that in the traffic obeying is the camera. The reasons for utilizing radars for sensing will be dealt in the later sections. The system described in [40] makes a binary decision as to whether it is safe to cross the road or not by observing oncoming traffic for a certain time interval. It also deals with the signalized and unsignalized crossing situations using classifier techniques like random forest classifier, Support Vector Machines (SVM) and k-Nearest Neighbors (kNN) with models trained from data sets which are publicly available¹. But unlike this system our proposed sub-system makes the decision based on the tracked data and compare

it with a threshold to conclude safe to cross and this becomes an input for the path planning module. [39] describes ways to incorporate radar into automotive sector and we seek motivation in the same to extend this for SWs. We propose a Convolutional Neural Network (CNN) based algorithm to detect the signs of the pedestrian traffic sign to categorize as “GO” and “STOP” signals. We describe the concept of our decentralized system in the block diagram shown below. It is worth noting that the path planning module encompasses collision avoidance subsystem. The radar and the tracking subsystem are responsible for avoiding any collision with moving vehicles. The CNN which is embedded in the visual processing subsystem provides the required input for the traffic obeying subsystem. The input here being the identification of the pedestrian signal. The component diagram describing our system is shown in the Fig. 1.

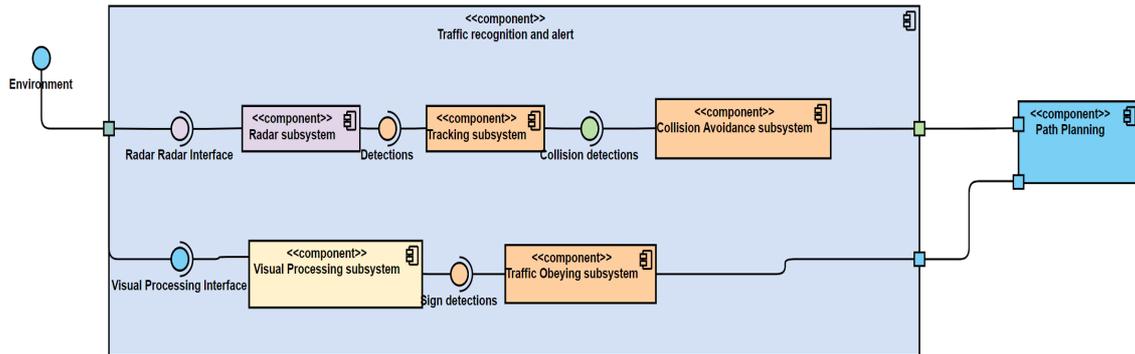


Fig. 1. Component diagram of Traffic recognition and alert

The underlying use case diagram is described in Fig. 2.

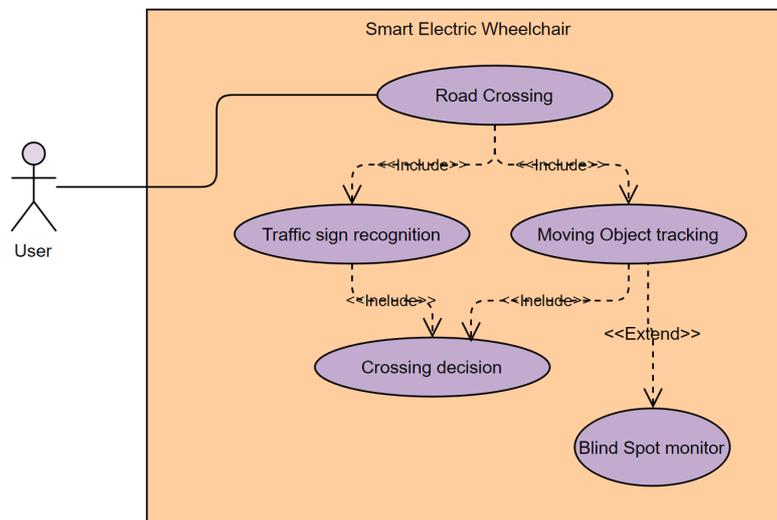


Fig. 2 Road crossing use for the above traffic recognition and alert sub system

3.2 Entering a Bus with Elevated Datum

If we Observe a bus ride with a person with mobility impairments, we will commonly notice that sometimes it is required for the bus driver or a fellow passenger to help or support the wheelchair in getting into the bus which poses a string challenge to the integrity of independent mobility. Works of [34] and [35] motivate us towards incorporating the solution of climbing elevated

platforms simultaneously balancing the mobile platform. Dean Kamen from DEKKA research came up with a sophisticated versatile robot capable of doing staircase climbing and other human mechanical activities. Beiquan et al. Other techniques include backstepping with Proportional Derivative (PD) control, fuzzy control, Linear Quadratic Regulator (LQR), adaptive control can also be employed to attain the desired controllability of the two-wheel tilt of the mobile base. [35] designed a model based integrated universal solution for real-world stair climbing situation using two different techniques ‘Wheel-Track Hybrid’ and ‘Length-Adaptable Platform’. A study on the currently available technologies resulted in our proposal of a simple backstepping with PD control for the SWs to climb the elevated datum. The challenge here mainly is to design an optimal controller for the SWs to work and operate for the desired scenario. For simplicity we propose a mode-based subsystem which results in the functioning of this activity. As soon as the climb mode is activated, the SWs are balanced with the rear wheels and climb the elevated datum with the front wheels. The activation is done with a user interface (e.g., a mode button). This activation with the sensor input (typically an inertial measurement unit) drives the controller and the respective control action is taken driving the electrical motors. The component diagram describing our system is depicted in the Fig. 3 and the use case diagram in Fig. 4.

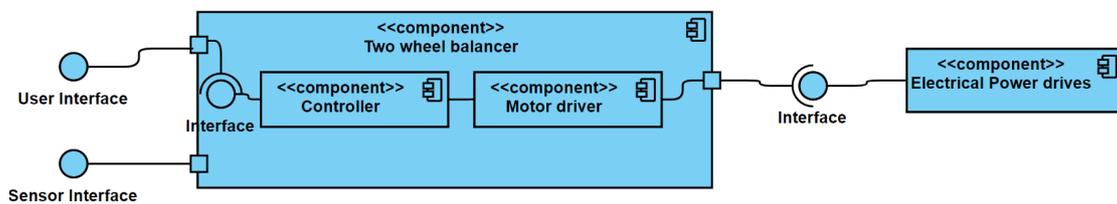


Fig. 3. Component Diagram of Two-wheel balancing sub-system.

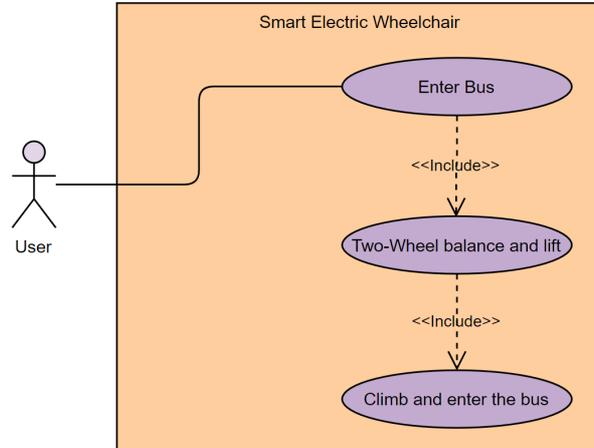


Fig.4. Use case diagram for entering a transport.

3.3 Efficient Maps in Highly Dynamic Scenarios

Planning a collision free path for SWs can be performed with the help of Simultaneous Localization and Mapping (SLAM), a concept through which a mobile platform knows its position and orientation or combinedly its state with respect to the surrounding environment. Enumerating different techniques and sensor usage in getting a map, the works of [36] and [38] was to autonomously navigate the SWs in outdoor with 2D projected maps from 3D Normal Distribution Transform (NDT) maps. The experiment was carried out with 3D LiDAR in fusion with Inertial Measurement Units (IMUs) for map generation.

Research works [37] provide a comparative study on localization by radar and lidar. It is worth noting here that conditions such as smoke, dust, or fire, can corrupt lidar measurements since laser beams become less efficient in environment with smoke or dust. On the other hand, radars are unaffected by smoke which make them great candidates for our use case. However, they typically have lower accuracy than lidars and unavoidable noise, e.g., noise induced by multi-bounce reflections. The below figure shows the potential growth of radar sensors in Europe with constant reduction in price and its ever demand in the market. Although all the automotive sensors are increasingly becoming cheaper, advancements in the domain of radar sensing technologies have proved to further reduce the cost of the overall sensor.

The ongoing improvements and advantages of radar sensor in comparison with its counter parts like lidar and sonar further prove to be promising on the everlasting demand for the future. Global market research companies like fortune business insights forecast that the radar business is sure enough to hit new heights in Europe. A study by system plus consulting on the economics of the radar sensor system has shown a decline in the over cost of the radar sensor over the years with improvements in the quality. The data shown in Fig. 5 is just approximations based on the idea to show the trend in reduction of the price of the radar sensors as advertised by prominent manufacturers of radar in automotive field. Since it was not possible to get the exact numbers for the figure, the numbers have been replaced with letters to depict the trend. The magnitude of value represents the unit price of the sensor in euros, increases from A to E. Mathematically $0 < A < B < C < D < E$ is the increasing order of number value in the graph given below. Today we get TI evaluation boards for 250 euros.

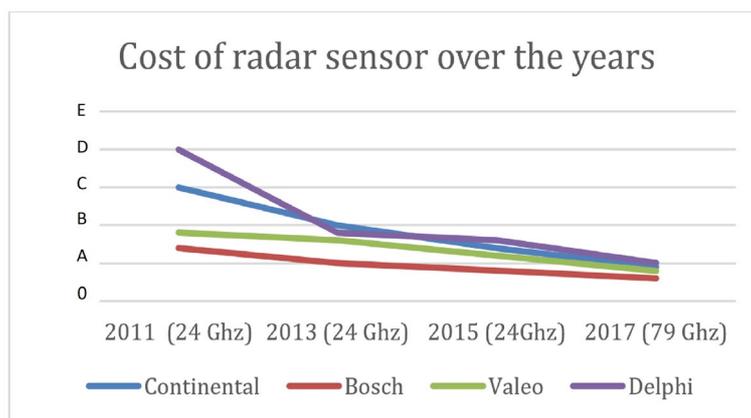


Fig. 5. Evolution of radar sensor cost, source: system plus consulting

There are a lot of challenges in obtaining a collision free route for an autonomous mobile platform and the complexity changes with dynamics and the contents of environments. Example, for planning a motion in a supermarket, generating a collision free path is challenging even with the available technological advancements. The classical approach of categorizing into stationary and non-stationary and tracking the moving objects with standard tracking mechanisms proves to be challenging and not efficient. Works of [36] and [38] helps us to understand that path planning algorithms can be extended to dynamic 3D environments mapped using NDT. The experiment was carried out with lidar sensors, which stand on top when it comes to cost factors. Bearing this we propose a localization and motion planning based on fusion of 2D lidar and 3D radar to produce an efficient 3D-NDT maps. A collision free path can be planned from the generated map for the mobile platform. We depict our system component through Fig. 6.

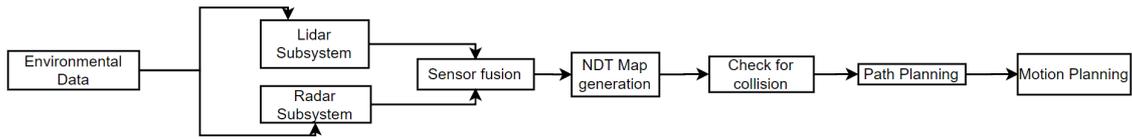


Fig. 6. Component diagram of Dynamic obstacle avoidance system

Driving through a highly populated and dynamic environment using the collision avoidance system through a use case diagram is depicted in the Fig. 7.

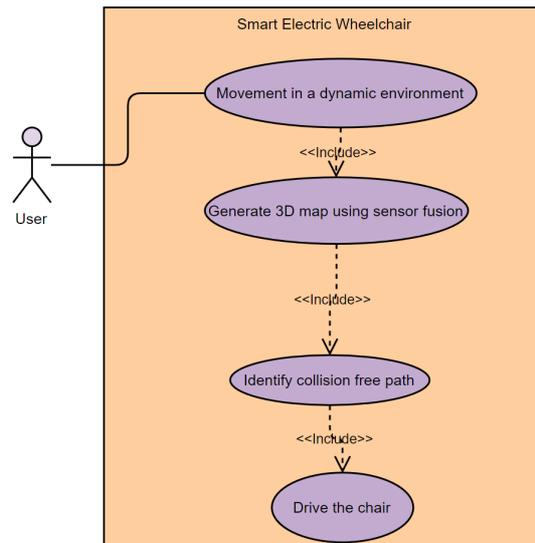


Fig 7. Using the dynamic obstacle avoidance system

4. Summary and Conclusion

In this paper we have presented a short study on the evolution of smart wheelchairs and a comparison with regards to technology and implementation. A functional study on currently available technological advancements and available feature improvements, led us to come up with some suggestions for improvements. These improvements will make the electric wheelchairs even smarter. While addressing the solutions we have also presented some cost factors and how the solutions can be implemented without compromising the quality factor.

A study on the research done in the past and a link between the past and the current field of research has also been presented. Having provided the overall study on smart wheelchairs, we have extended the scope of intelligence by enumerating some problems which have not been part of the current research, to the best knowledge of the authors. We have addressed possible contemporary solutions to the enlisted problems through features and improvements and depicted them with use cases and component block diagrams. Including the above discussed features and improvement does enhance the intelligence of the smart electric wheelchairs improving the activities of daily lives of people thereby paving the wave for the next generation.

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REVIEW OF SECURED METHODS FOR IMPLEMENTING UNIFIED HEALTH INFORMATION RECORDS AND PROPOSAL OF A HEALTH RECOMMENDER SYSTEM

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Abstract: *The continuous advancement of technology and the drive to make patients stewards over their health records has led to the development of applications that subsumes patient's data under a single umbrella called a Personal Health Record. The implementation of such systems gives the patients ultimate control over who gets to see his or her health records and what kind of data the authorized agent can have access to. Moreover, it opens doors for innovative ideas that strive for access to unified patient health records. However, the implementation of a single store for such sensitive data needs to be carried out and monitored by a non-profit and transparent body, which holds the interest of patients' high and must be implemented on a secured or if possible, a tamper-proof technology. This paper aims to review some of the secured technologies used to develop PHRs and propose a recommendation system that utilizes patient data to render useful services.*

Keywords: digital identity, blockchain, electronic health record, patient 2.0, personal health records

1. Introduction

The growth of technology has helped flourish many sectors including the healthcare sector. Where technology is facilitating the jump into a digital health transformation to enable health professionals to provide support and treatment using advanced tools to patients. Nowadays, many healthcare systems are trying to upgrade themselves for a better version of digital health by applying digital solutions [1].

Digital Identity is now playing a crucial role in the way of applying the digital transformation. It is important to think of digital identity as the building block for any digital system that is going to be under development. The concept is representing the identity of the entity that will be using the system like persons, devices, or organizations so, it is critical to have accurate information about the digital entity and to define its attribute clearly [2]. According to Sullivan Clare [3], who explained the nature and the working mechanism of digital identity in her published paper "Digital Identity – From emergent legal concept to a new reality", she stated that the most important part in the digital identity schemes is the 'Transaction Identity' because it represents the information that the user will provide to complete the transaction, and this information should be unique on the individual level. It might represent as an example: full name, date of birth, gender, and PIN. The main function of transactional identity is to authenticate the person by recognizing him/her via his/her information, and then to enable the needed transaction. Moreover, she explained that digital identity mainly depends on two processes: identity authentication at the time of registration, and verification at the time of the transaction [3]. On the other hand, digital identity aspects were identified by L. Jean Camp [4], like unique identifier, attributes, and identification which is defined by combining the unique identifier and the attributes. For example, the unique identifier could be the date of birth and the attributes are name, address, and eye color. So, by having the later information, it will be applicable to determine the identification [4]. Nowadays,

many studies are putting a lot of effort to develop the technology to accurately define users who will be interacting with a system, and to confirm their attributes like name, address, credit record, hobbies, and health status. So, it is important to think about security measures to ensure data privacy and prevent unauthorized access to the data [2].

The rest of the paper is organized as follows: section 2: patient's role in the health sector; section 3, patient empowerment; section 4, a review of three methods to securely apply digital identity in the health sector: Open ID, AppArmor, and Blockchain; section 5, recommendation systems concepts; section 6, our recommendation to provide a Health Recommendation System using blockchain technology; section 7, the conclusion.

2. The Patient's Role in Today's World

What is it like to be a patient in the 21st century? Over the period, did the roles potentially transform? Falcao-reis, et al. [5] defines this scenario as: "To be a patient in the 21st century is to be a 'patient 2.0', deeply connected with emergent new technologies and highly motivated to assume control and responsibility for his/her healthcare" [4, p. 3]. To extend this definition; just like every other domain in today's world, the term "patient 2.0" indicates the foundation of an advanced and improved version of its predecessor versions. This implies that a path has been set up towards the betterment of a patient's health or in other terms, it determines a step taken for 'patient empowerment. With the advent of this delightful concept, there comes room for a few notions: How would they educate themselves with their Electronic Health Record (EHR)? To what extent EHR will effectively help patients optimize and enhance their healthcare options? All of these issue-driven questions could better be answered by collective decisions and various thoughts of laymen, who may or may not be willing to see themselves as active users of EHR [5].

3. Patient Empowerment

Upon rigorous consideration, it will be evident that the accomplishment of the patient 2.0 manifesto is not just in the hands of tech professionals who can offer nothing but a smart health monitoring system. This is more of a collective task among patients and health professionals with interactive health information systems that will lead to more productive and happening results in a short burst. According to the illustration and overview of few studies regarding the involvement of patients in the process of designing these tools, one of the surprising factors of this keen conception which got quite noticeable is that not only can their wellbeing be better, but fewer individuals will wind up visiting medical emergencies prematurely as they engage in their healthcare [6]. This mutual engagement would contribute to decision making and being educated regarding health problems, which will ultimately reduce operational costs, and consequently making patients empowered [5].

4. Review for Secure Ways to Apply Digital Identity in the Health Sector

4.1 Expanding Patient Empowerment with OpenID

In today's modern world, there fall numerous ideas to help patients improve their health. One of these ideas suggests the utilization and maintaining of Personal Health Records (PHR) for which there are multiple existing platforms such as Google Health and some social networking sites where people discuss their health issues [7]. However, with the expanding number of this kind of health website, patients are forced to create their accounts allowing their data to be shared over the internet. Usually, they register themselves on various, portals and eventually fall into a situation, where keeping track of their credentials for each account seems pretty burdensome. Under these circumstances, these patients end up using the same set of credentials for all of their accounts, compromising their security to a great extent. The constant increase of privacy incidents targeting personal health data is the core factor that bawls for a need to raise awareness for patients

over the privacy and security of EHRs. To settle these issues, it is important to have a system that could provide digital identity tools which can help them secure their privacy. One of the possible solutions is an OpenID protocol that could be used to alleviate these problems [5].

“OpenID is a decentralized system protocol for user-centric identification and digital identity management on the Internet” [5, p. 5]. By using OpenID, patients can conveniently build their healthcare persona with characteristics they deem suitable, thereby avoiding active and integrated replication of data over the Internet. It offers users to create an account once which can be used for multiple websites; this takes off the need for the users to memorize the set of credentials for their different accounts, and this eventually resolves the case of a user having various identities. However, the fact that spammers can register identities exponentially and the OpenID platform could be vulnerable to spoofing/phishing attacks, makes this system distinctly lacking in the domain of security which still leaves room for unticked measures associated with a fully-fledged EHR of a patient [5, 8].

4.2 AppArmor

AppArmor is an open-source software project, defines as a Linux Security Module (LSM). It aims to provide mandatory access control (MAC) in a way to be isolated from the process to provide a high level of privacy and security. Its features are divided into high-level or low-level features. High-level tools are responsible for the generation and the validation of security policies, whereas features of the low level are for creating, manage and apply the access control rules from the Linux kernel [9]. However, creating the configuration of the security policy is considered complex and requires a high level of professionalism. For that, ASPGen was introduced to optimize the AppArmor security policy generation process, where ASPGen will act as a new framework for the automatic generation of AppArmor security policies. It will overcome the complexity of the manual configuration of the AppArmor [10]. On the other hand, a study by Ecarot et al [9] revealed that AppArmor LSM is vulnerable to side-channel attacks and it should be applied alongside a strong defense strategy. This result was conducted after applying a white-box code analysis to study data structure in the LSM. Authentication risk might be found in the profile and command management module that interacts with user-space, and it might happen if a user creates a profile and then this profile is modified by the administrator or another user. Other risks might appear like the man in the middle attack due to the rewrite of system functions by the LSM mediation module, it might happen when a third-party process accesses the LSM mediation function. Finally, there might be risks concerning integrity and confidentiality when the heap memory zone is corrupted which affects the profile storage and the matching engine [9].

4.3 Blockchain-Based Patient Identity System and Health Information Exchange

Since the invention of Blockchain (BC) technology By Nakamoto in 2008, the technology continuously increases in fame in numerous fields of research and practice. The technology is explained in detail by [11-12] including a survey of the opportunities it presents and its shortfalls [13]. BC features such as security, irreversibility, immutability, persistence, and decentralization have stirred a major rise in concept developments and inventions in other domains such as healthcare [14], identity management services [15-16], IoTs [17], and others.

In search for ways to make patients stewards over their data and also have a single identity that links to all of a patient’s health records (Health Information Exchange (HIE)), some healthcare researchers see BC technology as a vital component. HIE is a policy act and details are provided by [18-19]. BC technology is considered to increase the security and reliability of patient data and help in other healthcare areas such as drug prescription, data exchange, anti-counterfeiting drugs, medical history, and others [20]. Succinctly, BC offers reliable distributed and centralized

systems using cryptographic techniques [21]. In the remaining part of this section, we will focus on research works conducted on blockchain use for implementing patient digital identity and HIE. Harrison and Booth [22] describe the implementation of a patient-driven interoperability architecture and how it evolves a whole country's health system. They suggest that the governance and business models surrounding health record systems will have to change in such architecture. That is, the need for a trusted host of patient records and such a host must be a non-profit organization with transparent financial records and one that is considered to uphold in high esteem patient's needs. Such a trusted agent could be the government. For instance, Germany has launched and commenced the use of an Electronic Health Record from 1st January 2021 that provides a central location for patient health records [23].

Moreover, Wolfond [24] also describes the importance of BC in identity verification challenges. In his research paper, his focus goes beyond patient identity to citizen identification as a whole in Canada. The author outlined that the use of BC technology does not only solve the challenges (security, single point of failure) of a traditional identity-brokerage system but also fulfills the required needs of an identity system as described by the United States National Institute of Standards and Technology (NIST) [25]. The author also included that such a secure way of implementing EPR will inevitably improve patient engagement and enhance better treatment.

Houtan et al. [26] performed a survey on the use of BC technology in implementing identity management. Their survey utilized realized BC-based patient digital identity systems such as Electronic Health Record (EHR) and Patient Health Records. Upon their investigation of the state-of-the-art BC technology, implementation of a decentralized HIS requires “[...] a trade-off between factors such as level of decentralization, privacy, scalability, and data throughput” [26]. For instance, Medibloc, a Korean company that develops a patient-centric storage system, utilizes a hybrid architecture to curb the cost of storing large clinical data on BC platforms such as Ethereum. Medibloc stores the patient data either on the patient's device or in a centralized storage unit and encrypts the data using the Merkle tree for access control. The root of the hashed data is stored on the BC and points to the actual data. Users' data are only accessible via data decryption with the user's private key [26]. Jacobovitz [15] also outlines some companies that have implemented BC-based digital identity systems. Aydar & Ayvaz [27] also proposed a BC-based identity system using the hybrid method where the data is not stored on BC but only the proof of transaction or proof of records originality are stored on the BC. However, it is uncertain as to whether this approach can resist future complications as advancement in computing power poses a threat of being able to decrypt the encrypted data without the owner's private key [28].

Moreover, the shift from institution-centric interoperability (sharing of data among partnering institutions) of health records to patient-centric seems to excite researchers, inventors, and patients as well. A survey conducted by Bertelsmann Stiftung [29] reveals that two-thirds of patients in Germany want to be involved in their health decisions and would also like to read their doctor's notes. This survey signifies how patients would like to be stewards of their health data. Gordon & Catalini [30] provides practical scenarios in which BC technology can expedite this shift based on categories such as “[...] digital access rule management, data aggregation, data liquidity, patient identity, and data immutability” [30]. Making patients stewards of their data means that patient controls access to their data through smart contracts containing authorization rules and the BC keeps an audit log of all access ensuring that all data accesses are recorded and trackable. However, the authors outlined barriers and some possible mitigations to patient-centric interoperability. One of which was a concern of privacy. BC immutability feature means that patient data cannot be deleted, however, this violates the European Union's General Data Protection Regulation of “right to erasure” which permits an individual to request for the deletion of his/her data under certain circumstances [31]. A possible solution for this challenge is the use of a hybrid architecture like the one adopted by Medibloc [26,30].

Furthermore, Rituraj & Kumar [32] proposed a PHR system with blockchain and Mixnode. The Role of the BC in their proposed system is similar to other works stated above. The mix network, a.k.a Mixnode was used to authenticate and ensure anonymity by breaking any traceable communication link between data exchange parties (patients, health institutions, and other institutions the patient grants access to his/her data) in the system. This means that, even if an attacker can intercept the communication, he/she will not be able to link the data to anyone. Moreover, the authors structured PHRs into classes to ensure forward secrecy, thus, a data access agent with a key to an older class of PHRs cannot access a higher class. Katuwal et al. [33] indicate the major setback of “lack of trust and lack of incentive to share data” for the traditional institution-centric and patient-centric interoperability can be solved by BC technology. That is, the BC can act as the trust agent ensuring confidentiality and privacy and also motivate people to share data for clinical purposes by giving out crypto gifts for data sharing. The authors also suggest that BC can enable medical practitioners to have access to patient-generated data from healthcare IoTs such as smartwatches and this could aid in accurate diagnosis and treatment of patients.

Esmailzadeh & Mirzaei [34] performed an experimental study on the perceived benefits of BC-based HIE from patients’ perspective and the results indicated that patients are willing and happy to have such a system based on BC technology where they can see all their health records and know who is accessing which records even when there is no strong policy available. However, the authors’ findings also revealed that patients’ BC-based HIE opt-in heavily depends on the level of insights the patient is given on the BC-based HIE.

5. Recommendation Systems

Recommendation systems are software applications that utilize user’s data to suggest products and services that may be beneficial to the user. A common example of a recommendation is an advertisement recommendation system (ARS). Anyone that uses a smartphone can testify that he/she has seen advertisements that are related to a recent search he/she did with a search engine. Moreover, the data that is been used by a recommendation system could be implicitly or explicitly acquired by the recommendation system [35]. The explicit acquisition of user preference data occurs when a user enters his/her preferences in a recommendation system whilst the implicit method (context-aware recommendation system (CARS)) utilizes intelligent algorithms and user’s IoT devices to caption user’s preferences based on his/her behavior.

There are numerous recommendation systems available today in various fields such as tourism, entertainment, online shopping, and healthcare [36]. Each of these recommendation systems has unique features that distinguish them. Setten et al. [37] proposed a recommender system called COMPASS that utilizes tourist locations to recommend attractive places. This is useful in cases when the tourist is new to a particular location. A similar application was proposed by Majid et al. [38]. However, their proposed system utilized social media photo tags of places a user has visited to set up the user’s preference for recommending new tourist sites. In healthcare, a couple of RS has been proposed to suggest products for patients. Ali et al. [39] proposed a recommender system that takes patient (diabetes patients) data from wearables and suggests prescriptions for their smart drug boxes and food items that are good for their health. Kulkarni et al. [40] thoroughly exams the state-of-the-art intelligent algorithms used in acquiring contextual user data and improving upon the quality-of-service delivery of CARS. The authors in their review gave a plethora of examples of recommendation systems in two broad categories (bio-inspired and statistical computing techniques) with sub-branches.

6. Recommendation

With the growing demand of making patients' stewards of their health records and unifying all records from different institutions, patients will have an increased number of opportunities to share their data for efficient services. Accountability of data usage can also be ensured with the audit trail feature in a blockchain solution [30]. Recommendation of products such as food items based on his/her health records is one of the services a patient can enjoy. Such a system will utilize food repositories (for example, open food Repo [41]), drug repositories, and the patient's records. An example of a drug repository is the ABDA-Bundesvereinigung Deutscher Apothekerverbände (Federal Union of German Associations of Pharmacists) Database which is developed and maintained by the Bundesinstitut für Arzneimittel und Medizinprodukte (BfArM), translated into English as the Federal Institute for Drugs and Medical Devices, in accordance with § 67a of the German Drug Act (Arzneimittelgesetz (AMG)) [42] and can be accessed at fee [43]. The database contains all registered drugs in Germany information including their adverse reactions, pharmaceutical substances, active ingredients, and latest news [44]. For instance, if a patient would like to buy milk, the recommender system will match the patient's records such as allergies and drugs' chemicals/substances against the ingredients in a specified milk type and suggest as to whether the patient is safe with the milk or not. The recommender system could be equipped with features such as showing the patient where he/she can get a specific product to buy in his/her locale. Moreover, the mobile application of the system will allow users to scan a products barcode in addition to the normal form search.

7. Conclusion

At present, Personal Health Records unequivocally point towards the process of “patient empowerment” due to the fact that it conveniently helps the patients constantly keep an eye on their medical information. This process of patient empowerment cannot be accomplished only by educating patients about the significance it bears but also the frontline healthcare providers need to get involved with their patients personally to build a relationship that eliminates the temporizing effect, which will result in patients taking more interest in self-managing their health. Information technology plays a vital role in helping patients get easy access to their PHRs while not compromising security. There are different approaches to effectively maintaining patient's records while minimizing privacy invasion. For instance, OpenID protocol efficiently allows a “single-sign-on” feature but the vulnerability of spoofing attacks incapacitates it. However, Blockchain-based patient identity system diminishes this unshielded aspect of OpenID. All emergent new technologies digitalizing the health records of patients pave numerous ways to adapt these technologies to solve their health problems and promote health to a new level. However, adjusting to these technological advancements undoubtedly remains a lengthy process which demands a collaborative indulgence of various bodies bearing different roles.

8. References

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THE CHALLENGES FOR INTERNATIONAL COOPERATION OF THE PERUVIAN NETWORK FOR THE INTERNATIONALIZATION OF HIGHER UNIVERSITY EDUCATION: AN EXPLORATORY STUDY

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Abstract: *University network creation is a phenomenon that nowadays has become more and more common around the world. These networks are created so universities can join forces and cooperate to achieve specific goals. There has been little research on networks in Latin America and, specifically, in Peru, where the Peruvian Network for the Internationalization of Higher University Education (REDIPERU) has recently been established. This study is relevant because it is important to understand university internationalization and how it promotes educational quality, facilitating joint research and the training of human capital. This study presents the factors that were a challenge for internationalization at Peruvian universities both before the pandemic and in the current context.*

Keywords: internationalization, higher education, international cooperation

1. Introduction

The relationship-building between universities in order to form networks and carry out international cooperation has been studied in the field of Internationalization at higher education institutions (HEI), and in most countries HEI development has been influenced by internationalization [1]. As pointed out by Szyszlo [2], internationalization is a concept that cannot always be clear, and some attempts are made to explore the rationales, strategies and outcomes of international education efforts.

International cooperation and internationalization at the university level demands a set of resources that should be provided by the institutions; these include human resources, technical resources, and financial resources. Also, a context and country policies to facilitate and promote the actions that are embedded in international cooperation are necessary. In this context, this article presents the results of an exploratory study applied to the Peruvian Network for the Internationalization of Higher University Education (REDIPERU) members. This study relies on the importance of networks and internationalization to support the advancement of modern education in Peru, an emerging country. First, a literature review is presented on the importance of internationalization in HEI, the regulatory context of the tertiary education sector in Peru, the origin and launch of REDIPERU, and how this new organization is facing challenges in the current context of the pandemic. Second, the status of the universities that are network members and the internationalization actions they carry out are reviewed; this information was gathered via a survey administered before the pandemic. Additionally, a second survey examined the impact of their actions and their perspectives on internationalization in the midst of the pandemic.

2. The Relevance of Internationalization in HEI

It is important to explain the importance of HEI. In 2005, Elkin et al. [3] stated the following:

Internationalization should aim to create values, beliefs and intellectual insight in which both domestic and international students and staff participate and benefit equally. It should develop global perspectives, international and cultural and ethical sensitivity and useful knowledge, skills and attitudes for the globalised marketplace.

As there have been few studies on internationalization in Latin America, it is important to explain the situation in the region. In Latin America [3], business schools have not yet been able to train students who are equipped to support companies in their own internationalization processes. This can be interpreted as a sign that further cooperation among universities in the region is needed so that all institutions—both HEI and businesses—can enjoy the benefits of internationalization.

According to Knight [4], internationalization in education is more than the process of the bilateral integration of cultures: it also integrates participants internationally in terms of teaching, research, and service to their HEI. Regarding the impact of internationalization on reputation and the differences between private and public institutions, in 2020, Quinteiro [5] pointed out that rankings can be used to measure universities' internationalization. In the case of the Times Higher Education World University Ranking, it accounts for 7.5% of a university's total ranking. Institutions not only seek to climb within national rankings but also in international rankings. When they excel, they demonstrate that they are apt to receive students, lecturers, and researchers from other countries. Many times, this is reflected in the most recognized universities in a country, which also make large investments to improve overall educational quality and infrastructure.

3. The Regulatory Context in Peru and the Founding of REDIPERU

The Peruvian higher educational system has gone through a process of reform in the last six years. In 2014, New University Law No. 30220 mentioned the consideration or support for internationalization in higher education, based on one of the fourteen principles of Article 5, where universities are obliged to internationalize their institutions in order to become more competitive. Then, Article 48 focuses on research: universities must consider research essential and obligatory, whether that research is national or international in nature.

Additionally, the Peruvian government began supervising universities through the Ministry of Education; to this end, it created a new institution called the National Superintendence of University Education (SUNEDU). These actions were important because, on the one hand, SUNEDU could obligate universities to meet nine standards for quality control if they wanted to continue operating in Peru; this, in turn, forced public and private universities to revise their procedures and improve them. Second, for the first time, “internationalization” was mentioned in a law referring to higher education as one of 17 principles meant to guide Peruvian universities. This is a first step that recognizes the importance of internationalization in the work of improving the quality of Peruvian education.

The review and evaluation of universities have been crucial in the Peruvian educational system. Between December 2015 to December 2017, 141 universities and 2 postgraduate schools submitted their applications to obtain institutional licensing. As of March 2021, 92 universities and 2 postgraduate schools had passed the evaluation and been licensed. On the other hand, 49 universities and 2 postgraduate schools were told they may no longer offer educational services and must close within the next two years. This means that fully 35% of Peruvian HEI have not fulfilled the minimum requirements to continue operating.

Moreover, although internationalization has not been part of the basic conditions supervised by the universities, the results provide an important overview of the situation Peruvian universities find themselves in. Consistently, in terms of the internationalization of higher education in Peru, it can be established that only a small percentage of the universities has been working consciously

on this process. Peruvian universities are not ranked highly in worldwide university rankings, which use internationalization as one of the indicators. That is why working in networks has been a necessary step to represent the Peruvian system of higher education abroad.

REDIPERU was founded in 2015 as the initiative of a group of eight universities, two public universities and six private non-profit universities. The Ministry of Education also lent its support to the building of a “brand” of Peruvian higher education. In May 2016, REDIPERU reached an important milestone when it not only attended the NAFSA (Association of International Educations) international conference in the United States but also set up a booth to expose itself at said conference. That same year, the minutes that formally recognized REDIPERU were signed by the rectors of the eight founding universities. Currently, 15 institutions are members of REDIPERU: Universidad Nacional Agraria La Molina, Lima, Universidad Nacional de Ingeniería, Lima, Pontificia Universidad Católica del Perú, Lima, Universidad del Pacífico, Lima, Universidad de Lima, Lima, Universidad ESAN, Lima, Universidad Peruana Cayetano Heredia, Lima, Universidad de Piura, Lima and Piura, Universidad Católica San Pablo, Arequipa, Universidad Católica de Santa María, Arequipa, Universidad Nacional de San Agustín, Arequipa, Universidad Nacional de San Antonio Abad del Cusco, Cusco, Universidad Andina del Cusco, Cusco, Universidad Nacional del Centro del Perú, Huancayo and Universidad Ricardo Palma, Lima. According to Kameko (1996, cited in [3]), governments have increasingly begun to consider the role of higher education within their policy objectives, which have a strong international emphasis.

4. Research Design

As a new network of 15 universities with different backgrounds and perspectives, this exploratory study looks to identify the characteristics and main variables that affect internationalization in Peruvian universities. The first survey was conducted before the pandemic in December 2019, and the second survey was carried out in March 2021, after the first year the pandemic; this second survey was carried out to explore the impact of the pandemic on the priorities and the development of internationalization at the universities. The directors or coordinators of internationalization of twelve HEI responded to both surveys. To measure some of the main variables of internationalization, the survey was based on Gao’s [6] approach, which identifies universities’ primary motivations for embracing an internationalization agenda, that agenda including student mobility, research, faculty, curriculum, commitment, and governance. The questions in the survey were designed with care to cover all of Gao's variables.

5. Findings

There is no single recipe for internationalization, and every university can have different objectives in this process. That is why the survey asked respondents to point out which internationalization goals were most important for their respective institutions. The list of options and answers was as follows in Table 1.

Peruvian universities indicate that research is a top priority, as they have been tasked with the production of knowledge and development in Peru. Peru spends only 0.08% of its GDP on research and development, a figure well below what Colombia (0.25%) or Chile (0.38%) invest. Universities are conscious of this situation, and internationalization could be a path to strengthen the research at their institutions and in the country as a whole.

TABLE I. Main Findings Surveys Pre-Pandemic and Post-Pandemic

Aspects	Survey 1, Pre-pandemic	Survey 2, Post-pandemic
Establishment of agreements with prestigious universities	41.67% of respondents gave a rating of 6 out of 7 possible points. Weighted average: 5.60.	42% of respondents gave a rating of 7. It has increased by 17%.
Promotion of exchange programs for incoming and outgoing students and professors	33.33% of respondents gave a rating of 6, and another 33.33% gave a rating of 7. Weighted average: 5.70.	16.67% of respondents gave a rating of 6, and another 41.67% gave a rating of 7.
Promotion and support to the strengthening of research	58.33% of respondents gave a rating of 7. Weighted average: 6.40.	41.67% of respondents gave a rating of 7. Weighted average: 5.58.
Attraction of international students to the institution	41.67% of respondents gave a rating of 6, and another 41.67% gave a rating of 7. Weighted average: 6.10.	41.67% of respondents gave a rating of 6, and another 16.67% gave a rating of 7.
Internationalization of the curriculum	41.67% of respondents gave a rating of 7. Weighted average: 5.50.	50% of respondents gave a rating from 6 to 7. Weighted average: 5.42.
Development of international courses in the virtual modality	33.33% of respondents gave a rating of 7. Weighted average: 4.90.	33.33% of respondents gave a rating of 7.
Development of joint double degree programs	33.33% of respondents gave a rating of 5. Weighted average of 5.08.	8.33% of respondents gave a rating of 5.
Consideration in international rankings	50% of respondents gave a rating of 5. Weighted average: 5.50.	25% of respondents gave a rating of 6, and 33.33% of respondents gave a rating of 7.

On the other hand, most Peruvian universities face the problem that they are not attractive to international students. Indeed, this is not a problem only for Peruvian universities but also for universities throughout Latin America and the Caribbean, which is considered to be one of the least attractive regions on the international level, according to UNESCO – IESALC [7].

Of the 5 million students [engaged in mobility programs], only 176,000, 3.5% of the total, choose a country in this region as their destination. Of these, 69% come from the region, an additional 12% from North America and Western Europe and the rest from other regions.

Latin American universities deal with similar problems and have similar needs, which can be transformed into great possibilities. HEI in Latin American must be attractive not only as a “landing place” for visiting faculty and international students to conduct tourism but also as a place to receive rigorous academic training.

Furthermore, universities were asked to list the internal obstacles they face when attempting to internationalize. Answers indicate that Administrative inertia, bureaucracy, the absence of institutional policies and procedures and Limited financial resources were the most important barriers that managers have to address internally. Among the other options of lesser importance are the following: Inflexible curriculum that hinders validation processes, Little interest among the faculty in mobility and collaboration with foreign peers, and Difficulty in handling the English language among the faculty.

Bureaucracy and the non-existence of internal policies or procedures, particularly at public universities, could be an important barrier to the development of new internationalization

strategies. As mentioned before, governmental regulations concerning internationalization are basic or nonexistent, as there is no national policy framework that supports each university's initiatives. In fact, the situation in the region is similar to what de Witt, Gacel, and Knobert [8] describe:

At the national level, several countries have recently developed international strategies, most of them in the form of scholarship programs. On the continental level, some sub-regional policies have emerged, but, on the whole, there is "Latin American internationalization policy" as can be found in other parts in the world.

Most Peruvian universities have internal regulations only for their mobility programs but have not outlined internal regulations for other activities and are still struggling to raise awareness and gain support from their universities' authorities, as shown by the limited financial resources they are granted. For example, only six out of the fifteen universities in REDIPERU actively participate in the NAFSA Annual Conference, which means that fewer than the 50% of REDIPERU's members actively participate; moreover, REDIPERU members' participation in EAIE conferences has decreased: only two or three Peruvian universities attend this international forum regularly.

In addition to internal difficulties, universities were asked to rank six external obstacles to internationalization. Overall, respondents placed the limited recognition of the country's ability to offer a superior education of excellence at the top of the list. As a matter of fact, although rankings are not always synonymous with quality, Peruvian universities are almost absent from the main higher education rankings when compared to other countries in the region. This reveals the absence of a national strategy for internationalization that could recognize Peruvian HEI as attractive destinations for international faculty and students. As a matter of fact, some Peruvian universities do possess prestigious international accreditations in different fields and programs, like, for example, AACSB International, which has accredited the business programs of Universidad ESAN, Universidad del Pacífico, and PUCP Centrum.

The other external obstacles listed in order of importance are It is not a priority of national policies, Reduced public financing for students' and professors' mobility, Unclear visas processes for academic stays in Peru, Perception of insecurity in Peru, and, finally, Limited recognition of foreign degrees and academic diplomas.

6. The Impact of the Pandemic on Peruvian Universities

COVID-19 has altered the situation and the actions carried out by HEI on a global level. The IAU Global Survey report [9] (2020, p. 8) states, "According to UNESCO, on 1 April 2020, schools and higher education institutions (HEIs) were closed in 185 countries, affecting 1,542,412,000 learners, which constitute 89.4% of total enrolled learners".

In Peru, all university campuses were closed at the beginning of the Peruvian academic year in March 2020, when the national lockdown was instituted. According to Peruvian regulations, academic programs that had been established as face-to-face programs were required to go online, although most HEI lacked experience in the virtual modality. The pandemic created a great challenge for Peruvian universities: the need to adapt their programs and activities so they could be carried out via virtual platforms.

Most of the well-known private universities were the first to overcome this challenge and successfully adapt their classes and curricula to the new virtual modality, but it took several months for public universities to respond adequately. The government assigned extra financial resources to public universities to provide the training, technical support, and infrastructure

necessary to continue the academic year. Additionally, and importantly, this situation forced a change in the university law: now students are able to continue their university studies in person, virtually, or via a blended modality. The prejudice against online education has been dismissed, and, from now on, local regulations and university licensing procedures also take into account blended and virtual modalities. As the academic environment had changed, a second survey was administered among REDIPERU members to explore their priorities and adaptability to the new virtual modality.

When comparing the two sets of responses, it can be identified that responses to the question about the most important goals of internationalization vary. Prior to the pandemic, the top priorities identified were promotion and support to the strengthening of research and the attraction of international students to the university, but one year after the pandemic began, member universities indicated that the internationalization of the curriculum was also a high priority. Online education created a series of challenges but also opportunities to enhance universities' internationalization processes, especially those that could be carried out without travel. Peruvian universities realized that the internationalization of the curriculum was necessary and achievable both in person and virtually.

While the predominance of the virtual modality had had an impact on all REDIPERU member universities, each one had responded and adapted to this new situation differently, enacting strategies and internationalization processes that varied by institution. When asked what activities they had been participating in since the beginning of the pandemic, the universities listed the following, in order of importance: Virtual mobility, OUTGOING: students from Peru were enrolling in universities abroad (19%), Virtual mobility, INCOMING: international students were enrolling at Peruvian institutions (16%), Virtual visiting professor programs (14%), Virtual conferences (webinars) (14%), Reciprocal faculty lectures (14%), Organization of virtual fairs with partner universities (12%), Collaborative online international learning, COIL (11%).

In addition to the question about new activities, the universities were asked about the impact the pandemic had had on their international offices. This question was asked because it had come to REDIPERU's attention that some universities, both members and nonmembers of REDIPERU, were reducing the number of employees in their international offices and eliminating most of the budget regularly assigned to trips to attend conferences and otherwise represent their universities abroad and because, for many universities, the number of online internationalization activities had increased, as had stress levels due to working from home.

REDIPERU members responded that the pandemic had had the following impacts, in order of importance: Increase in new virtual activities and projects (20%), Access to free internationalization training (18%), Greater communication with partners or colleagues abroad (17%), Low prioritization within the university's strategic plan (15%), Decreased number of personnel assigned to the office (12%), Eradication of the office budget (10%).

Finally, in terms of mobility, the effect of the pandemic is clear, as so far, travel restrictions imposed due to COVID-19 have paralyzed face-to-face mobility programs. Before the pandemic, member universities used to send their students abroad; the numbers they sent abroad varied by institution. The 2019 survey indicated that 16% of the universities used to send more than 250 students abroad per year, 8% sent between 101 and 250 students, 16% sent between 51 and 100 students, 33% sent between 21 and 50, and 25% sent fewer than 20 students per year. Although these numbers could be considered insignificant compared with the figures of universities in other countries, they reflect the real situation of REDIPERU's member institutions. Indeed, although physical student mobility has been a challenge due to factors like the finances, this is all the more reason for the implementation of virtual mobility programs, where the barriers are not financial but are related only to timetables, language, the validation of credits, and how flexible each

university is when it comes to allowing its students to be enrolled in foreign universities online while remaining at home.

The virtual mobility programs that were implemented in 2020 permitted REDIPERU students to study abroad despite the barrier to physically do so. The second survey showed that 46% of universities managed to enroll fewer than 20 students abroad, while 27% sent between 21 and 50, and another 27% sent 51 to 100 students during the spring and mostly the fall semester, 2020.

Similar patterns emerge concerning incoming students. The survey from 2019 shows that 8% of the universities welcomed more than 250 foreign students per year, while another 8% welcomed between 101 and 250 students, 67% welcomed between 21 and 100, and 17% welcomed fewer than 20 international students per year. These numbers reveal why one of the top priorities for the universities is to be attractive to international students. Moreover, just as it had for outgoing students, the pandemic negatively impacted the number of incoming students. The 2020 survey, which took into account virtual mobility, reported that 40% of the universities received or enrolled fewer than 20 students; another 40% received between 21 and 50 students, and only 20% welcomed between 51 and 100 international students. However, it is also important to mention that two universities didn't report their virtual mobility numbers, meaning they had not activated this new internationalization strategy. Also, it is important to mention that these numbers are considerably lower than average because not many students were able to engage in physical mobility, and the virtual mobility strategy was activated only in the second half of the 2020 academic year.

7. Conclusions

The process of internationalization in Peruvian universities is still in its beginning stages, but its importance was recognized by the state in 2014 by New University Law No. 30220 and by the universities themselves through the creation of networks like REDIPERU in 2016. These steps strengthen internationalization processes in Peruvian HEI and have been necessary to help member universities overcome internal and external obstacles. Furthermore, it is important to mention that member universities have identified that their membership in REDIPERU has increased their international exposure and provided them with the opportunity to participate in different activities, like webinars, meetings, and interactions with stakeholders, which provide new opportunities and the ability to learn from others, as well as to share experiences with other members.

Another important factor to be considered is that the REDIPERU network is promoting and contributing to the strengthening of research through collaboration with other networks in the Latin American region. It is crucial to consider internationalization as a key factor to improve the quality and the impact of the research carried out in Peru. This, in turn, will help member universities move up in the rankings and consolidate the excellence of Peruvian education. The pandemic has highlighted the importance of research, and those who coordinate international offices in HEI are aware of all the possibilities offered. However, for this to happen, it is necessary for both national authorities and the administration of each university to provide students, faculty, and researchers with the resources they need. In the same way, universities must review and assess their programs, looking for more opportunities to attract international students and to internationalize the curriculum.

Although the pandemic has negatively affected student and faculty mobility and the development of new international projects, it has also provided a great opportunity to rethink and create new ways to collaborate and to run multicultural activities online. The virtual modality has helped universities partner together more easily than ever before: with just one click, new prospects for collaboration across borders can now be opened. Finally, international cooperation within the

Latin American region has been initiated, and it is being promoted through REDIPERU's participation as a founding member of INILAT, the Latin American Initiative for the Internationalization of Higher Education. The aim is to strengthen the collaboration between Latin American HEI in the midst of the current pandemic. Each of INILAT's six-member countries is leading a work project to benefit the whole network. In Argentina, FIESA-REDCIUN-CIN (the International Higher Education Fair of Argentina - International Cooperation Network of National Universities in the Argentine Republic) is committed to searching for sources of funding and the generation of international partnerships that will strengthen Latin American networks. In Brazil, FAUBAI (the Brazilian Association for International Education) is in charge of the implementation of Collaborative Online International Learning (COIL) in the region. In Chile, Learn Chile is working on the creation of a regional virtual exchange program. In Colombia, RCI (the Colombian Network for Higher Education Internationalization) is developing a Latin American Internationalization agenda and organizing INILAT events so universities can exchange best practices and position Latin America in the international education sector. In Mexico, AMPEI (the Mexican Association for International Education) is focusing on the identification of public policies to support the internationalization of higher education systems in the region. Finally, in Peru, REDIPERU is concentrating on the generation of initiatives to boost the internationalization of research by increasing contact between researchers in the region.

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TRANSFORMATIONAL COMPETENCES FOR INTERNATIONALIZATION FACING COVID-19 AND POST-COVID-19 SCENARIOS

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Abstract: *The project about transformational competences development facing contingency scenarios and new world perspectives is part of DIES Training Course “Management of Internationalization 2020-21”. It is oriented to analyze and develop transformational competences facing COVID-19 and post-COVID-19 scenarios, from different Higher Education IO Staffs. Interview guides applied and content analysis carried out are contributing to build a “Glossary of transformational competences, skills, facing changing scenarios”. The main skills identified are inference, communication, diffusion, teamwork, collaboration, social support, networking, confidence reinforcement, flexibility, adaptability, acceptance of diversity, resilience, organization / planning, decision making. After the research phase, LINED project team will design, plan and implement training actions to enhance National University of Mar del Plata Staff’ transformational competences. Training results will be assed considering satisfaction and learning levels. The training results will promote constructive dialogues at International Higher Education Fair Argentina (FIESA), it will take place next year in Mar del Plata city.*

Keywords: internationalization, international office, transformational competences, COVID-19

1. Introduction

Effects of the COVID-19 pandemic are challenging Higher Education Institutions. HEIs must focus not on the content but on the competences: to face the uncertainty, to be resilient, to develop critical thinking considering dynamic, diversity and complexity conditions, to be entrepreneurs in crisis, to be flexible and plastic, to tolerate frustration, to manage anxiety and stress, to manage innovative projects facing new challenges with social and environmental impact (located diagnosis, design, planning, implementation, evaluation of processes and results). On the other hand, the social isolation revealed deep states of inequality related connectivity conditions, ICTs training (Information and Communication Technologies), work overload, overlapping of work and family roles, gender perspective, among others [1].

IO Staffs are not immune to these limitations and changes. The pandemic brought both, a massive new dynamic and role in internationalization processes. Regional structures, such as networks, groups, associations become much more frequent than face-to-face. One of the most used tools has been the virtual mobility of students, teachers, researchers, extension workers and managers. Internationalization at home, Internationalization of the Curriculum, Collaborative Online International Learning, Mirror Classes and Double Degrees have been taking a strong role to complement the mobility deficit.

This project is part of DIES Training Course “Management of Internationalization 2020-21”, its main goal is to analyze and develop IO Staffs’ transformational competences facing COVID-19. National University of Mar del Plata (UNMDP) is co-organizing with the National Inter University Council of Argentina (CIN) the next International Higher Education Fair Argentina

(FIESA 2022). It is an international meeting of Universities, Institutes, Embassies, Associations and International Networks of Higher Education from around the world.

This fair is challenging us, we are a small group of administrative and technicians performing individually specific tasks and we really need to perform like a synergic high-performance team. Through this project, we can learn successfully from other IO Staffs who have been improving competences facing COVID-19.

We formulated the project goals considering some crucial characteristics: related to an area of improvement (specific goals); related to indicators of progress, deliverable outputs and outcomes (measurable goals); related to specific roles (assignable goals), achieved considering available resources (realistic goals); related to two different phases: research phase and training phase (time-related goals).

2. Methodology

Considering these previous conditions, the four project goals are:

- 1) To identify which transformational competences facing contingency and changing scenarios are being developed by IO Staffs from Latin America and the Caribbean during 2020 and 2021.
- 2) To develop UNMDP Staff 'transformational competences facing contingency and changing scenarios through specific training actions.
- 3) To diffuse and discuss main project results at FIESA 2022.
- 4) To assess training results regarding satisfaction and learning levels.

Therefore, this project will contribute to assess and train transformational competences, improving UNMDP strategic actions for Internationalization.



Fig. 1. Relationships between goals, project phases and time schedule

Following Avolio and Bass [4] transformational dimensions are oriented to influence changes, they are four:

- a) *Individual consideration*, which requires empathy, understanding diverse expectations and communication skills.
- b) *Intellectual stimulation*, which requires hypothesis and inference thinking, flexibility, adaptability, creativity, innovation, proactivity and critical thinking.

- c) *Inspirational motivation*, related to teamwork performance, optimistic and enthusiastic attitudes.
- d) *Idealized influence*, related to the coherence between what we say and how we behave, also related to confidence processes.

We are applying and collecting lessons learned by IO Staffs from Latin America and the Caribbean facing COVID-19 scenario. Through those lessons, we are now working on transformational competences identification and classification. After this research phase, we are going to design and plan training actions agenda and program (content and methodology specifications) and we are going to implement them to improve UNMDP Staff competences. After the training phase, we expect to disseminate out results in a special dialogue session during FIESA 2022. Finally, satisfaction and learning questionnaires are going to be applied to measure Staffs perceptions and acquired competences.

3. Stakeholders

We consider external and internal stakeholders which are collaborating with this project. As external stakeholders (from outside UNMDP) we identify: National Inter University Council Decision Makers; IO Staffs from Latin America and the Caribbean; DIES Training Course Professors and Staff; FIESA 2022 Organizational Committee; they are legitimating the project and sharing internationalization practices and experiences. As internal stakeholders (from UNMDP) we identify: National University of Mar del Plata (UNMDP) Decision Makers, IO Staff and LINED (International Education Laboratory) Research Team; they are supporting, diffusing and collecting data, respectively. The next Figure shows the stakeholders classification and the roles distribution.



Fig. 2. Stakeholders and roles

4. Results and Conclusions

From October 2020 to February 2021 were invested time in project chart formulation, assessment and improvement considering DIES Training Course 1st and 2nd workshops learnings, professors' comments and feedback received. We were investing in communication and marketing strategies emphasizing the project impact and benefits, to mitigate the possible low IO Staffs' participation. Interview guides we designed to collect IO Staffs' lessons learned

from Latin America and the Caribbean during March, April and May 2021 (most of them are participating in DIES Training Course 2020-21). To assure a coherent interview guide application, we trained three interviewers. We have interviewed IO Decision Makers from Argentina, Chile, Colombia, Costa Rica, México, Peru and Honduras. LINED (International Education Laboratory) Research Team is carrying out the initial content analysis, which includes listing lessons learned by IO Staffs facing COVID-19 scenario and transformational competences identifications and classifying.

The main competences that we are identifying in I/O Staffs' lessons learned are:

- *Hypothetical thinking*: to build inferential responses and develop lateral thinking to cope with changing scenarios.
- *Communication skills*: to listen actively and understand Higher Education community and internationalization needs, to understand and be understood effectively by others.
- *Collaborative working*: to develop teamwork and networking processes between I/O stakeholders and external stakeholders.
- *Confidence reinforcement*: to influence I/O members' confidence perceptions through healthy support and feedback.
- *Flexibility*: to generate alternative strategies and resources adapting to unexpected changing scenarios.
- *Acceptance of diversity*: to tolerate differences found in groups of people regarding race, religion, culture, ability, age, or gender.
- *Resilience*: to adapt and grow following adversity and obstacles, to cope with intense and critical emotions.
- *Organization*: to plan I/O working agenda, time schedule and coordinate specific staff activities.
- *Decision making*: to analyze problems and formulate resolutions considering I/O priorities.

Most of these identified competences relate directly to the four transformational dimensions of Avolio and Bass model. For example, communication skills and acceptance to diversity are competences related to Individual Consideration; hypothetical thinking and flexibility are competences related to Intellectual Stimulation; collaborative working and resilience are related to Inspirational Motivation; confidence reinforcement is related to Idealized Influence.

As challenges, these competences need to be improved in I/O Staffs:

- *Marketing skills*: to diffuse I/O information efficiently involving internal and external stakeholders.
- *Acceptance of uncertainty*: to tolerate unknown, non-controlled and unpredictable situations and cope with them.
- *Persuasion*: to sensitize and influence I/O internal and external stakeholders involving them in changing processes.
- *Project systematization*: to assess integrally I/O processes and results considering retrospective and prospective scenarios.
- *Work overload management*: to understand stressful situations and I/O resources to cope with them.
- *Connectivity management*: to support right tools to ensure optimum connectivity and manage social media and digital devices and deployments.

- *Fundraising skills: to identify internationalization funding opportunities offered by associations, corporations and foundations and to develop internal financial support strategies.*
- *Innovation: to implement creative ideas, to generate innovative processes, products and/or services to cope with changes.*

We are sensitizing UNMDP Staff through communication of training actions benefits, designing virtual training actions to facilitate the UNMDP Staff participating.

We are going to assess the entire project considering valuation criteria and mechanisms to support its success. We are going to measure satisfaction and learning levels, which is: (a) to ask about training levels of satisfaction through a short quantitative questionnaire including: content and methodology assessment; and (b) to ask about transformational competences learned through training actions and to think about how to face contingency scenarios with all these tools (a short-written assignment). We are going to diffuse project main results during FIESA 2022.

The pandemic will leave scars and new scenarios in HEIs. Experiences, learnings, innovations, mistakes and successes. The current crisis is transforming Education asking for transformational tools like the ones we analyze in this project. An education oriented towards the development of world citizenship and ODS must consider the cognitive, socio-emotional and behavioral dimensions [2]. HEIs must focus not on the content but on the competences (knowledge, skills and attitudes developed in-situation), which are valued and useful for sustainable development: critical thinking, social responsibility, solidarity, empathy, acceptance of diversity, equity, social leadership, collaboration, problem solving, among others, considering adverse socioeconomic realities, common inequities and challenges with regional implications [1] [3] [5]. We found most of those competences in Staffs' learnings analyzed.

Regarding this project sustainability, we will continue researching competences for internationalization at LINED-UNMDP (International Education Laboratory), diffusing the results, and involving more researchers in this topic. We will implement training actions each year to improve regularly UNMDP Staff' competences, so new editions of these training actions will come.

Finally, we consider important to emphasize these project results as relevant information to plan new strategic actions for future DIES Training Course generations.

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COVID-19 AND TEACHER CONTINUING EDUCATION: THE INNOVAT PROJECT STRATEGIES TO SUPPORT HIGHER EDUCATION IN CHILE AND PERU

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Abstract: *COVID-19 has shifted overnight the higher education traditional delivery, deeply impacting teaching and learning worldwide. As a response to this challenge, the InnovaT project has re-designed a planned blended teacher training concept into a full e-learning experience for university teachers in less than 90 days. The new plan included a combination of webinars, a 6-week MOOC and exploratory interactive workshops. The overall reach of the updated learning pathway was more than 10 times bigger, with a multinational and multidisciplinary community of more than 1,300 learners for the MOOC and a high level of contentment from the participants in all phases.*

Keywords: COVID-19, higher education, innovation, e-learning, teacher training, MOOCs

1. Introduction

The conventional concept of teaching and learning is undergoing significant changes. The Covid-19 pandemic has raised significant challenges for the higher education community worldwide. The urgent and unexpected request for traditional university courses to be taught online, involved the need for rapid designing and organizing teaching practices assuring continued education of students and good learning experiences, with the support of digital technologies [1]–[4].

The pace of response of higher education institutions (HEIs) was different depending on several factors, such as the macroeconomic context (developed, emerging, not developed economies), the geographic location, type of university (public, private), and the institutional technical infrastructure available, among others [4], [5]. The need to create new online learning environments to continue education implied decisions, choices, and adaptations from universities, with the intention to meet both, the students' expectations as well as the teachers' requirements. HEIs were facing in positive and negative experiences in accommodating to the unexpected switch to remote teaching [6]–[8].

The InnovaT project, launched in January 2019 in an initiative of nine universities from Austria, Spain, The Netherlands, Chile, and Peru with the aim to enhance innovation in teaching and learning methods and to integrate new digital tools in higher education [9]. In the context of this capacity building project, the delivery of teachers' trainings was at its core. The original learning approach for the capacity building was defined as blended, combining face-to-face workshops in the premises of partners in Chile and Peru, with a massive open online course (MOOC) of six weeks. By February 2020, the original trainings and topics were developed to be undertaken in April and May 2020, in two partner universities. With the closure of the universities and COVID-19 restrictions in all countries and partner institutions, the original training concept was re-designed into a full e-learning experience, integrating webinars and exploratory interactive workshops as the main strategy to substitute the face to face trainings, fostering to advance the

digital literacy of university teachers and support them in the pressing challenge of emergence remote teaching (Fig. 1).

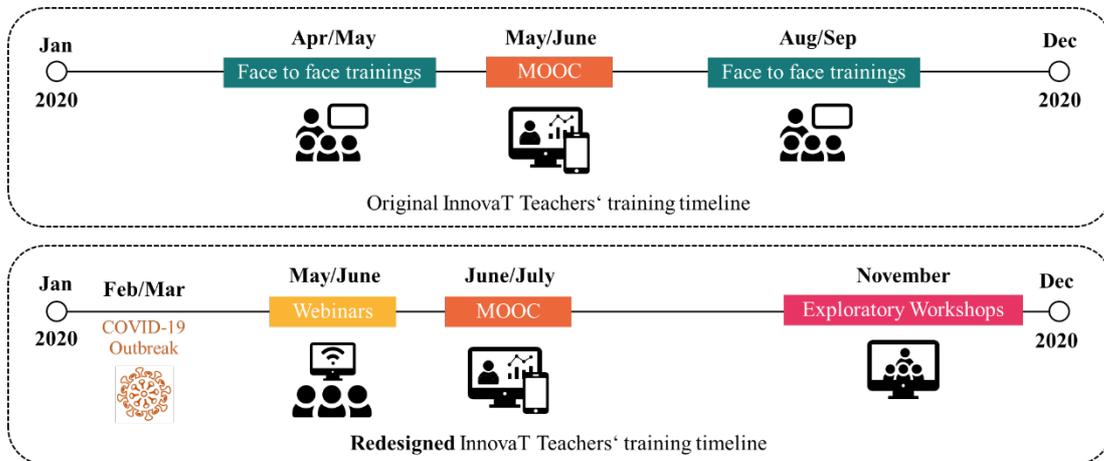


Fig. 1. InnovaT Learning journey timeline before and after COVID-19

After more than one year of the COVID-19 pandemic outbreak, there are significant opportunities to learn from the strategies and practices undertaken by other universities and projects. Making them available to a broader spectrum, can certainly strengthen our collective response into the future. Therefore, the aim of this paper is to report the strategies undertaken by the InnovaT project considering the COVID-19 restrictions, and how the challenge for delivering teachers' trainings have been overcome by the re-designed learning journey, impacting even a much broader audience for the capacity building in the higher education institutions in Chile and Peru.

2. InnovaT Webinars

The use of webinars to foster training and continuing education has taken a greater attention recently, and is also used as an effective tool to deliver lectures and tutorials in higher education [10]. Existing literature shows webinars to be as effective as lectures but that a practical framework is not always present to guide the design, delivery, and evaluate the webinars [11].

The InnovaT Webinar series was proposed as part of the contingency plan due to the COVID-19 outbreak in March 2020. Initially, each training was supposed to be conducted in person and at the premises of the Universities in Chile and Peru.

In replacement to the face-to-face trainings, four webinars with a duration of 75 minutes each took place and the specific themes of each webinar were selected according to the expectations, requirements, and most immediate needs of university teachers from the Latin American partner universities. In order to assure a broader reach and multiplication of the knowledge created, the webinar materials and presentations have been either directly developed and designed in Spanish or translated in the cases where trainers were English speakers.

Behind each of the webinars one European partner university was in the lead, and the trainers have been selected according to their experience in the topics selected by the Chilean and Peruvian partners for the webinars (Table 1).

TABLE I. InnovaT Webinars Overview

Item	Webinar title	Date	N. of registered participants	Leading Partner
1	Introduction to Innovative online learning and education	May 12 th , 2020	324	FH Joanneum University of Applied Sciences, AT (FHJ)
2	Educational online tools	May 19 th , 2020	333	Universidad Carlos III de Madrid, ES (UC3M)
3	Interaction in education and learning	May 26 th , 2020	342	Breda University of Applied Sciences, NL (BUas)
4	Time and resource management in learning and teaching	June 2 nd , 2020	340	FH Joanneum University of Applied Sciences, AT (FHJ)

The original target numbers were pointing at 60 participants for each webinar (as expected for the face-to-face trainings). The reached audience was five times higher than expected, with more than 320 registered participants from various disciplines. All participants received a certificate.

Webinar participants were asked to respond an evaluation survey about their experience with the webinars. A sample of 228 participants responded the survey and a very positive feedback was giving, especially mentioning that InnovaT webinar series came in at exactly the right time when needed to learn new skills and tolls for the remote teaching duties. Moreover, it was stated that the webinars provided a smoother path and boosted the participation in the next phase, being a very good preparation step into the InnovaT MOOC.

As the main results from the participants’ evaluation, it can be pointed out that the platform MS Teams has been evaluated positively, 176 of 211 participants (84%) rated it with 4 or 5 (very satisfied). The results in this category showed that the participants were mostly very satisfied with the overall organization, 204 of 212 participants (96%) rated it with 4 or 5 (very satisfied). Nobody rated it with 1 (not satisfied), as seen in Fig. 2. The only suggestions received were focused on improving the question and answers (Q&A) session and the provision of certificates in a simpler way. In general, the presentations of the four webinars have been evaluated positively in content, usefulness, and clarity. The moderators of Q&A were also positively evaluated, 175 of 187 participants (94%) rated it with 4 or 5 (very satisfied).

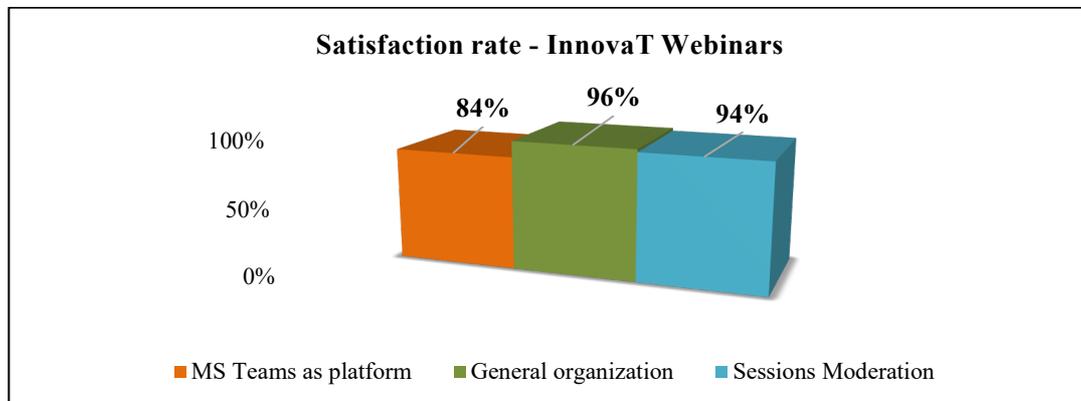


Fig. 2. Satisfaction rate of InnovaT webinars

3. InnovaT MOOC

The massive open online courses, known by the abbreviation of MOOCs, have been providing since 2011 a lifelong learning culture, helping to bridge geographical and economic barriers of learners, and also presenting positive impacts on higher education outcomes [12]. In the context of the InnovaT project, a MOOC was developed by the European partners as a main part of the capacity building training, having being part of its original plan and maintained also after the COVID-19 restrictions in the partner universities.

The InnovaT MOOC was designed with a duration of 6 weeks, with a total learners' workload equivalent to 1.5 ECTS (weekly workload of approximately 5-7 hours). The target learners were Latin American higher education teachers who wanted to innovate in their practices. The delivery dates were between June and July 2020. The MOOC was deployed in the Edge platform, which is powered by edX. Edge is a more private site and only learners who received the URL for the course could join it. Access to the course was free of charge and those learners who completed the course received a certificate from the InnovaT project.

The MOOC contained six main modules and was developed in collaboration between BUAs, UC3M and FHJ, considering the topics of their expertise and target group needs (Fig. 3).

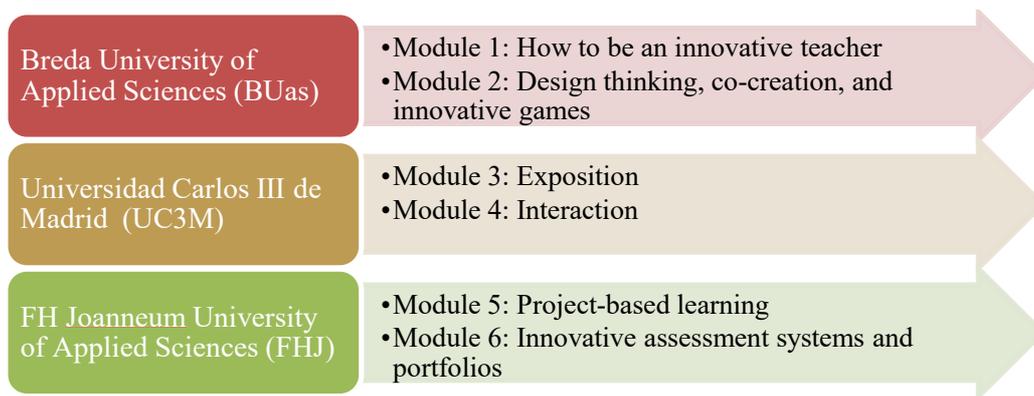


Fig. 3. InnovaT MOOC main modules

The MOOC included a collection of videos distributed in the six modules (13, 16, 13, 11, 13, and four videos respectively, plus the presentation video and six summary videos), as well as texts, additional reading materials, and infographics. In addition, a presentation module with information about the course and a farewell module with weekly summaries, and surveys was provided, as well as a transversal module with a peer assessment activity.

All videos were in Spanish or included closed captions for learners to follow them. All the modules contained formative assessment activities (more than 100 formative assessment activities overall) and summative assessment activities. The summative activities included a quiz (10-20 automatic correction exercises per quiz) at the end of the module with a weight of 12.5% per quiz plus the transversal peer assessment activity, in which learners had to design an innovative syllabus with a weight of 25% of the final grade. Learners needed 60 points out of 100 to get a certificate from the InnovaT project at the end of the course.

It is relevant to notice that the recording and editing of the videos were happening during the time when the majority of university campuses were closed and almost no access to the infrastructure of studios and professional equipment was given or available.

The InnovaT MOOC delivered in the redesigned plan had 1,339 enrolled participants of which 268 got a certificate. The completion rate was 20%, which is much higher than the usual completion rates that can be found in MOOCs.

Regarding demographics of enrollees, 884 (66.8%) were from Peru and 301 (22.7%) were from Chile, although 24 countries were represented, many of those from the Latin American Region (e.g., Mexico, Brazil, Colombia, Uruguay, Ecuador, or Venezuela, among others). There was a gender balance in participants with 50.4% male participants and 49.3% female participants. The level of education of participants was high due to the target audience of Latin American university teachers, being 99.6% of them with a higher education degree and 78.4% also having an advanced degree (master's degree or PhD). Finally, the median age was 45, and most of the participants were over 40 years old.

Learners very positively assessed the quality of the contents of each module (4.45, 4.47, 4.72, 4.77, 4.73, and 4.34, respectively in a 5-Point Likert scale (n=236). Similar positive results were obtained regarding the usefulness of each module (4.56, 4.57, 4.72, 4.79, 4.71, and 4.48), as illustrated in Fig. 4.

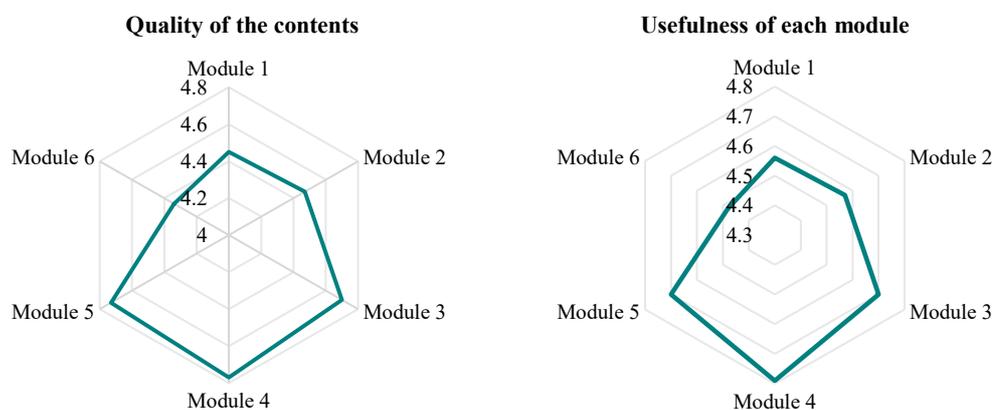


Fig. 4. Evaluation results on quality and usefulness MOOC modules

All the respondents (100%) indicated that they would recommend the MOOC, and 99.2% of them reported that they would take another MOOC. Participants also stressed a high level of contentment with the quality and clarity of the contents provided, the abundance of materials and references, the relevance of the topics, the high level of knowledge and skills of instructors, the applicable use cases presented, the fact the course was free and they could get a certificate of completion, and the experience of the peer assessment activity. Aspects reported to be improved from their perspective include the high workload of the course, the strict deadlines to complete summative assessment activities, the need to improve some summative assessment quizzes, the exploration of certain topics in more depth, or the reduction of the duration in some videos, among others.

4. InnovaT – Exploratory Interactive Workshops

Remote workshops are online meetings led by an instructor who brings a new skill, technique, or framework to a group of participants using digital platforms and tools. The participants and the instructor are usually in separate physical spaces, the interaction is synchronous and integrates hands-on work and engagement. This new way of collaboration was already defining the future of work and was accelerated by the COVID-19 [13].

The InnovaT Exploratory Interactive Workshops were provided as an alternative to the face-to-face trainings which were supposed to take place at the partner universities in Chile and Peru in April and May 2020 as well as in August and September 2020. The exploratory workshops were meant to close the teachers' learning journey in a more collaborative space, also integrating space for discussion of ideas and exchange of practices among participants and facilitators.

The Exploratory Interactive Workshop series consisted of six workshops delivered online in the period from November 16th-26th, 2020. They were conducted with 60 participants, divided in two groups of 30 teachers, 10 from each of the three Chilean and 10 from each of the three Peruvian university partners. The main language of instruction was Spanish, with interpreters doing translation of English delivered workshops. Each European partner university was responsible for delivering two topics and workshops (Table 2).

TABLE II. InnovaT Exploratory Workshops overview

Workshop title	Facilitating University	Date	Country
Teaching as facilitating and design	Breda University of Applied Sciences (BUAs)	November 16 th , 2020	Peru/Chile
Video recordings	Universidad Carlos III de Madrid (UC3M)	November 17 th , 2020	Peru/Chile
Games and playfulness in education	Breda University of Applied Sciences (BUAs)	November 18 th , 2020	Peru/Chile
Golden Standard PBL in Online Teaching	FH Joanneum University of Applied Sciences (FHJ)	November 23 rd , 2020	Peru/Chile
Shared whiteboards and documents	Universidad Carlos III de Madrid (UC3M)	November 24 th , 2020	Peru/Chile
Innovative and Online Assessment	FH Joanneum University of Applied Sciences (FHJ)	November 26 th , 2020	Peru/Chile

The participants were selected based on their participation in the webinars as well as their engagement, and completion of the MOOC, forming the groups with the most committed teachers in the InnovaT learning journey. The target number of 60 teachers was kept as in the original plan with the purpose to offer a more exploratory and interactive experience for the participants and foster a more collaborative learning as in the previous phases of the InnovaT learning journey (webinars and MOOC). All participants received a certificate of participation.

A survey evaluation was undertaken to evaluate the Exploratory Workshops by the participants. The main results based on a 5-Point Likert scale (n=60) indicated that the platforms selected for the workshops, namely ZOOM and Google Meet, have been evaluated positively and none of the participants reported problems with the platforms. The participants were mostly very satisfied with the overall organization, the mean score was 4.8, with no rating on scale 1 (Not satisfied).

In general, the presentations of the six workshops have been evaluated positively in content, usefulness, and clarity. Some respondents suggested there should have been more interaction between the speaker and the participants in particular cases. Also, some of them would have preferred even more practical content. Time management has been evaluated positively (mean 4.7). Some participants indicated that they would have preferred more time for activities and teamwork. The interpreters have been evaluated positively (mean 4.8).

The participants also expressed their positive attitude to mingling and exchanging with lecturers from different disciplines and universities and the benefit this brought to their learning in general. An important outcome of the workshop series was the willingness of the participants for a second round of workshops due to the relevance of the knowledge and practices shared.

5. Conclusion

The results from the InnovaT training plan redesigned during COVID-19 pandemic may represent a useful source for other universities and project consortiums facing the need to rapidly adapt teaching and training deliveries and for those searching for validated action plans. It was possible to see that setting up a fully digital learning journey - although not being a simple task - can be done successfully, even bringing possibilities to extend the reach and the impact of the trainings.

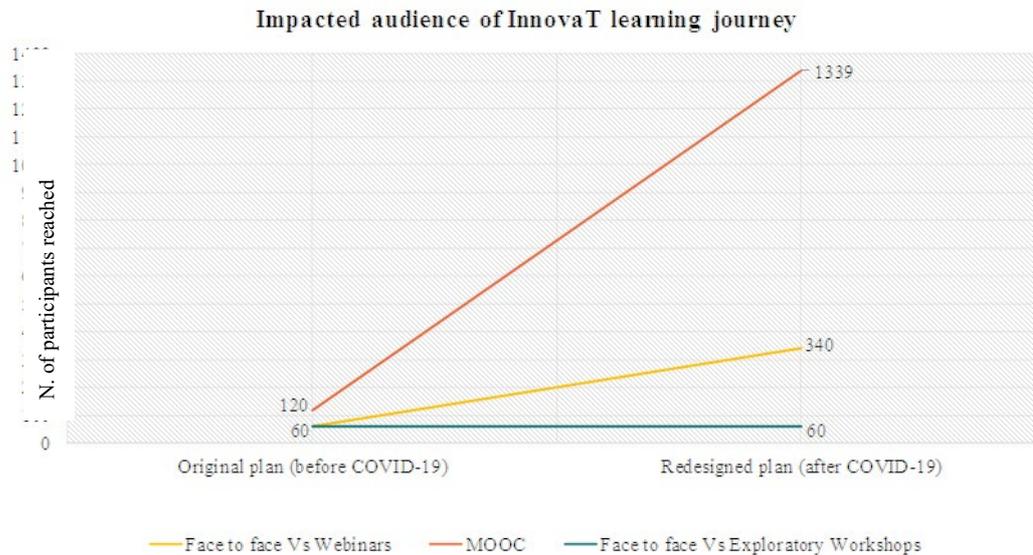


Fig. 6. Original target vs reached numbers of teachers impacted

With the redesign of the training plan of the InnovaT project after facing the COVID-19 pandemic, we were able to:

- shift from original face to face teaching to a full online learning in less than 90 days;
- reach an audience 10 times bigger than originally planned;
- certificate 268 teachers in innovative teaching and learning practices with planned innovation in their syllabus.

The importance of having a well-structured plan, key indicators to measure quality, usefulness, and satisfaction of the delivery are some of the learnings experienced. Also the flexibility of MOOCs in terms of learners' self-allocation of study time, can make of this form of online teaching a great tool for teachers' continuing education. The multiplication effect of webinars and interactive workshops, that can be recorded and accessed further, are also an excellent source for spreading the knowledge among universities, teachers and students worldwide. It is important to notice that, due to the travel limitations to the universities premises and the full online delivery, some budget savings could be available. However, it was learned that a redistribution of the remaining travel budget is highly needed to invest in extra staff hours used to the buildup materials for the new online delivery. In addition, the institutional support for the recording, editing and technical specification of online teaching materials is imperative to successfully replicate such actions.

Remote work and learning are trends that will keep shaping our lives, and it is also valid to higher education and training deliveries [13]. The digitalization is opening up a global window to higher education teachers, to collaborate with international universities, learn from peers and expand

their teaching and research activities outside the university buildings. Teacher's resilience and the eagerness to advance their practices was proven to be high in the context of the InnovaT Project.

6. Acknowledgement

We thank all partner universities, project staff and teachers that were highly committed in this very complex scenario and that kept eager to learn and advance as project consortium and as individuals: Universidad Austral de Chile, Universidad de Santiago de Chile, Universidad Viña del Mar, Universidad de Lima, Universidad de Piura, Universidad Católica San Pablo, Universidad Carlos III Madrid, Breda University of Applied Sciences, FH Joanneum University of Applied Sciences. This work was supported by the European Commission through Erasmus+ Capacity Building in the Field of Higher Education project InnovaT (598758-EPP-1-2018-1-AT-EPPKA2-CBHE-JP). This publication reflects the views only of the authors and funders cannot be held responsible for any use which may be made of the information contained therein.

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STRATEGIES TO FACE THE CHALLENGE OF VIRTUAL EDUCATION

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Abstract: *This contribution is made within the framework of the social isolation implemented as a preventive measure, given the current global pandemic situation. Such circumstances have an impact on the development of face to face classes on higher education. The experience of e-learning, at the School of Engineering of the University of Buenos Aires in 2020 and early 2021, is presented, with a focus on the work carried out by the Educational Technologies Center (CETEC, Centro de Tecnologías Educativas) of this institution. Various quantitative and qualitative results are shown, as well as the accomplishments and future challenges.*

Keywords: distance learning, university, teacher training, educational support, technopedagogical planning

1. Introduction

As a result of the sanitary protocols of social isolation implemented in this country, a Contingency Plan of Distance Learning is developing at the School of Engineering of the University of Buenos Aires. Such a plan, which was carried out throughout 2020 and which continues during 2021, is devised to allow students to continue studying engineering through distance learning modalities.

Universities had to change the way of teaching during 2020, and distance learning modalities were chosen. However, this was not compatible with all courses; some of them require special spaces which failed to be replicated online. This massive migration towards e-learning was the first challenge, since it required -as in this case- the activation in the institutional educational platform, managed in Moodle, of the classes of every course and course of studies. Consequently, a revision of available virtual classrooms needed to be made and new classrooms needed to be created.

The following challenge was the massive consulting and training of university teachers for the implementation of virtual education [1]. Classroom design, the use of campus resources and activities, the development of educational material, communication with students, and students' evaluation through virtual education were and are still the focal points for the teachers at the university. This situation leads to a change in their role.

The activities carried out and the challenges successfully overcome by the Educational Technologies Center (CETEC) of the School of Engineering are described herein, as well as the challenges still facing us. This occurs in the framework of the Contingency Plan and based on the different strategies that were implemented. Also, quantitative and qualitative data showing the levels of participation, didactic innovation and evaluation methods are detailed.

2. Implications of Virtual Education

In the educational area, response and adaptation to change are slow-moving since they require deep reflection and the application to diverse realities. Given the nature of such temporary process, when the educational system response finally arrives, it may happen that the situation that originally demanded the change, as well as the questions that derived from it, change

themselves. Conversely, during the pandemic, a change was required in an abrupt manner. The transformation from face to face education to online education was made whilst the institutions outsourced streaming services, increased connectivity, trained teachers, assessed the needs of the students and developed educational material. And that was something entirely unprecedented in the educational sphere.

The shift towards virtual education has consequences on students, such as lack of connection between classmates, among others. Peers' support has a high level of affective value. An isolated student may come to a dead end and abandon a course or become reluctant to use virtual education [2]. Thus, training and providing support to teachers is paramount. They must be able to teach online in the most efficient manner and, at the same time, reinforce the necessary support for the student to accept this modality of education and prevent them from growing resistant to the various methodologies which might be implemented.

The application of new technologies in university teaching serves as a review of the traditionally applied assumptions and methods, as well as it gives an opportunity to design new learning situations. Even though the integration of technologies does not guarantee any change in the teaching model or in the results of learning experiences, it makes it possible to rethink the pedagogic scenario [3]. Not only does it pose questions regarding its development within this context, but also it digs deep into face to face methodologies. For instance, shouldn't master classes give rise to flipped classrooms, where the focus is on the analysis of situations and issues under the light of theory, avoiding presenting the theory separated from practice? Another question is formulated based on the role of the teacher: how is it possible to move from being the center of the educational experience to fulfill other roles as creators of materials and content curators, and have a continuous tutorial function for tracking learning?

When moving from master classes to more interactive classes it is fundamental to think about the spaces where learning is going to happen and about the interaction among pedagogy, technology, and the design of learning spaces. When said areas are integrated, they make up what is called the ecosystem of active learning, where the challenge is giving an efficient answer to every process (strategic, fundamental and of support) of the educational context in which it exists [4]. As for learning, the most efficient assistance that can be offered to the student is the one that abides by the principle of "assistance adjustment", provided by the teacher in increments for the gradual acquisition of competencies linked to autonomous learning [5][6][7][8].

2.1 Contingency Plan

Within the framework of the resolutions issued by the Dean and Board of Directors, the Distance Education Committee for Covid-19 was created. This is composed of the Academic Management Secretary, the Student Engagement Coordination Area, the Educational Technologies Center (CETEC), and the Technologies Information Undersecretariat.

This Committee's mission is to plan, execute, and evaluate the extraordinary measures taken as a contingency for the development of online classes for the greatest number possible of subjects in the 12 engineering courses of studies, prioritizing those pertaining to basic sciences. Several strategies are contemplated, including the following:

- Providing a varied offer of remote activities for every course.
- Facilitating the use of every available tool by the teachers, for the unfolding of online classes.
- Being able to administer comprehensive evaluations.

To achieve these goals, a Contingency Plan has been implemented. This plan contemplates new work teams and the definition of their functions. The directors of departments and referents of each department were responsible for this endeavor, and they also act as a bridge between teachers and the CETEC. The FIUBA's Virtual Campus is defined as the institutional space for the development of online activities.

The CETEC organizes teachers' training. The training is carried out using a special classroom that allows teachers to share resources and doubts and to engage in self-managed learning (courses like MOOC) and workshops about the design of virtual classrooms, communication with students and online exams [9]-[12].

Before the beginning of online activities, the University of Buenos Aires defined a one-month-window for teachers to train in the use of specific technologies for e-learning, to facilitate the development or adaptation of theoretical and practical materials, and to carry out connectivity tests in synchronous activities. As a result of this work, educational materials such as videos, multimedia material, simulations, documents, etc. were designed and elaborated [13]. Repositories that include different educational materials to be shared among teachers of the same subject or department were developed. A survey of the available and required infrastructure was also carried out. Results showed a need for licenses for online classes, which were acquired; the number and capacity of the servers was increased to serve 2,000 students in critical time bands, and 11,000 students per day, and stress tests were done.

At the beginning, with the aim of organizing the necessary assistance for the different courses, three possible scenarios were identified: (a) courses which already had their virtual classroom; (b) courses where teachers had technological independence; and (c) courses where teachers required technological support. The structure of the institutional campus was adjusted to fit the new demands as well, with spaces for the teachers' departments, differentiated areas for the courses and virtual classrooms for every class.

This Plan relies on the following precedent on virtual education, 2006: creation of the Laboratory of Virtual Learning Environments; 2010: creation of the Distance Education Center, which changed its name to Educational Technologies Center in 2018, since, in practice, its functions have to do with every aspect of teaching and learning using technology. According to a survey conducted by CETEC in late 2019, 80% of undergraduate courses used the school campus as a supplement of face to face classes. It was used for different purposes: communicating with students, repository of material, self-evaluations, etc. Although this previous experience was not sufficient for implementing online classes, it did facilitate the transition to e-learning.

CETEC set it as its goal, from day one of the pandemic, to develop strategies designed to facilitate an expedited teacher training in the use of resources and to provide consistent support with counselling and in decision making. In view of that, it engineered a resource classroom in the very school campus which included video-tutorials, tools that facilitate the design and development of online classes, consultation forums, access to training courses, etc. The focus was on the need to organize a schedule that accommodated to a road map that was possible, and that contemplated diverse activities (study, exercises, communication, evaluation, group work) in the campus environment, supplemented by synchronous or asynchronous online classes [1].

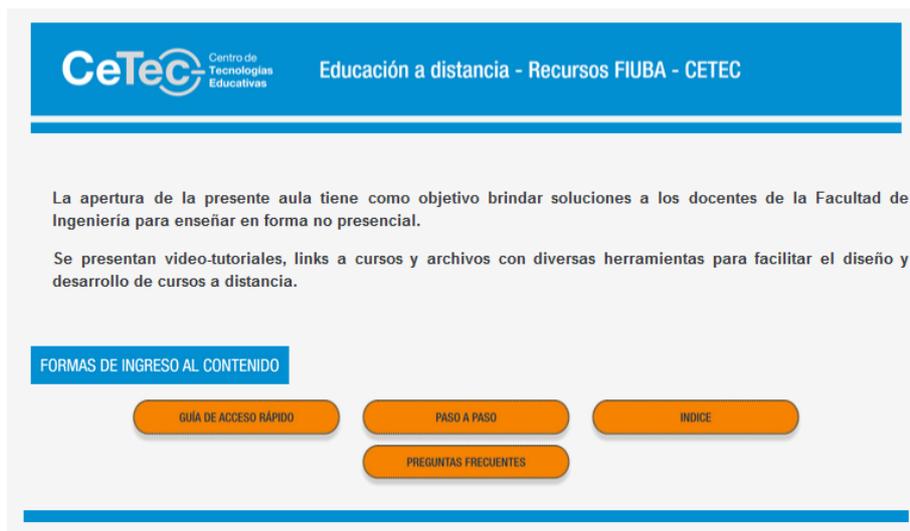


Fig. 1. Resource classroom

2.2 Teacher's Role

The Observatory of Educational Innovation of the University of Monterrey, as well as several Horizon reports, describes the change in the teacher's role as one of the biggest obstacles for the improvement of teaching practices [3]. Teachers' work has a twofold tendency: a competent performance and the use of technologies as a resource that facilitates learning. Some international organizations, such as the UNESCO, recommend incorporating TICs in education to expand the reach and promote social inclusion [9]. However, not all the inhabitants of a certain territory have access to the Internet. Therefore, this is an issue that must be dealt with when undertaking the transformation of a complete face to face education system into an online education system.

In the university education system, there is a tendency for lecture classes. Several reasons contribute to make the decision of implementing this technique, namely, the number of students (that, for basic sciences, amounts to 1,500, on average), the number of contents to be taught in a tight schedule, and tradition. When moving to a virtual environment, it is necessary to identify the new functions of the teacher, the ways and levels of interaction that can be attained, and the speed at which courses or educational materials may be studied [9][15]. This involves a change in the role of the teacher. Yet, it is a fact that when there is change, there is resistance to change. Thus, some teachers implement online classes in an attempt to copy face to face classes, failing to consider the inherent restrictions of a virtual environment: the student is at home, sharing the space with their family; they may share devices with another member of their family; they may have connection issues; among others. Furthermore, the teacher may be faced with the same restrictions. That is why training them on the different methodologies and tools offered by e-learning is so important in order to streamline the processes of teaching and learning. And, as important as training them is providing, at the institutional level, appropriate support to its whole educational community [16][17].

2.3 Evaluation

If we talk about evaluation, three concepts that are involved in its description should be differentiated: the means, the technique, and the instrument. The means refers to the proof or evidence employed to gather information about the goal of the evaluation (essay, written exam, report). The technique is the strategy used to systematically gather information (observations, interviews, documentary analysis, etc.). The instrument of evaluation is the tool employed to

evaluate learning, such as rubrics and scales, among others [18]. This introduction allows us to identify evaluation techniques as the main difficulty when implementing virtual education.

Distance education may facilitate an uninterrupted evaluation and foster the student's self-regulation better than face to face education. Virtual tools, such as self-evaluations, essays, and assignments encourage students to reflect upon their own learning process [19]. On the other hand, by means of the communication tools, it is possible to foster interaction and work on an error as part of the learning process.

The Distance Education Committee proposes a protocol of evaluations:

- Recommendations of questionnaire configuration in the virtual campus, including time limit and attempts, and random questions with sequential navigation.
- Accreditation of students' identity.
- Contingencies during evaluations. An explanation of how to proceed if a technical problem occurs that prevents the student from taking or sending the exam on time. After the exam, teachers must prepare a report. This will allow us to have a record of the failures to analyze and prevent future problems.

Moreover, diverse evaluation methods were presented, such as questionnaires, written exams by workshop, and oral exams through videoconference. It is important to highlight that exams are received through the Moodle platform. Simultaneous videoconferencing should also be used to monitor students' environment and interact with them. In exams with asynchronous instruments, an oral instance must be added where the authorship of the work is accredited. Teachers and students need to test the system in which the exam will unfold and detect possible problems (massive attendance, images that are not displayed, etc.).

To make management easier, exclusive exam classrooms are created, in which access is only granted to the teachers and students involved. The teacher responsible for the subject and the coordinator of the courses are set as classroom administrators. Some videos are available in the Resource classroom to carry out these tasks.

3. Results and Conclusion

In order to continue with the different courses of studies at the School of Engineering in an online education system, the institutional campus was employed, using Moodle. On average, 500 courses, 1,400 teachers, and 7,800 students are involved in the learning process each term. Among the measures implemented by the Contingency Plan, it is important to highlight the different types of support provided by CETEC to train teachers, namely, (a) resource classroom; (b) online consultation; (c) synchronous and asynchronous advice on various subjects, such as tracking and evaluation, forums functionality and online classes; d) dedicated workshops; and (e) training courses. These activities facilitate the migration to virtual education and reduce the teachers' demand for support.

The teachers' interest in modifying their teaching methodology and being trained on the tools that facilitate virtual education is evidenced by the number of enrollees in training courses. For instance, a SPOC course [20], which had 50 enrollees on average until 2020, escalated to 424 enrollees during 2020. The program offered on an Update on Engineering Teaching with TICs (which consists in 12 courses) multiplied the registration of attendees by four. Consults by streaming exceeded 1,300, while consults by e-mail were more than 900, and by form, a total of 222 up until this date. During 2020, licenses of streaming rooms were assigned and, in only two months, they amounted to 397 requests. The resource classroom, designed to provide support to teachers, received a huge load of enrollees once the school migrated to a complete online

modality. The peak number of actively participating teachers was 664. Consultations to teachers were enabled through forums, in the abovementioned courses, and through a form. As of this date, we have received more than 1,000 consults. As a result of these consults, a second SPOC was generated, aimed at answering most of the concerns raised by teachers. That task required 6 months of hard work.

Satisfaction surveys were carried out in courses for teachers. For example, it was observed that all the teachers who attended the SPOC saw it as a positive experience. They also evaluated the materials as adequate and recommended the course. These results motivated the creation of the second course, based on the questions asked by the teachers in the resource room. The surveys of the courses corresponding to the update program yielded similar results.

Throughout the past year, we managed to overcome many teachers' resistance to the use of technology and online education. Their motivation was evidenced by their autonomously learning to use other tools, different than those suggested in the courses. A significant change was observed on the number and quality of consults; not only did they decrease, but also, they exhibit a better understanding of the resources and activities of the campus. For instance, the use of questionnaires with calculated and nested questions, that allow for a more solid exam base, was not infrequent. Regarding scenarios of technological organization, it is of the utmost importance focusing on the following tasks:

- Boosting teachers' digital literacy, fostering the development of appropriate competencies for the use of technology.
- Rethinking the role of educators, considering other functions, such as that of content curators, designers, decision makers on the use of certain technologies, etc.
- Training teachers on techno-pedagogical design.
- Promoting teachers' engagement in communities and networks, facilitating training and exchange.
- Overcoming the tendency of migrating face to face classes to virtual classes without proper adaptation.

The challenges facing us this year are, in particular, the implementation of remote laboratories (some of which were developed prior to the pandemic); the accomplishment of a better way of tracking students' performance by means of certain AI techniques; the optimization of the questionnaires applied to evaluations; the application of proctoring systems in exams; and the creation of a repository of educational material of the institution that allows for both internal and external use. Another subject that is still under study is the impact analysis of the use of this modality for each course, by each department, and on an institutional level and, particularly, to what extent the massive introduction of technology covers the needs of students and teachers.

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DIGITAL TRANSFORMATION AND ITS IMPLICATIONS FOR LATIN AMERICAN UNIVERSITIES

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Abstract: “COVID-19 has accelerated the digital transformation of higher education” (World Economic Forum, 2020). Universities were forced to close their physical campus, change their strategies/processes/infrastructure/culture, and perform digitally. The arising question from this change in paradigm is whether the changes to the university system were: (a) digital transformation or (b) IT adaptation. The purpose of this mixed (quantitative-qualitative) study is to understand the implications for the universities and effectiveness of their digital transformation strategies using an adaption of the model of Marshall (2007 & 2013).

Keywords: digital, transformation, IT adaptation

1. Introduction

According to the World Economic Forum (2020), “COVID-19 has accelerated the digital transformation of higher education”. One of the strategic planning instruments adopted worldwide is the mission statement. A ubiquitous strategic planning instruments that determines the actual purpose and future course of action for organizations, and the related internal or external processes. [1]

Generally, mission statements integrate three specific components: teaching, research, and public service, which taken together should define the institution’s structure, the expected outcomes, and the terms for judging effectiveness, while also contributing to building organizational identity. Mission statements hold the foundation for effectively designing and implementing an institution’s strategy, which will lead to the achievement of institutional goals, and thus superior performance. [1]

Higher education today is marked by a series of changes and transformations that bring both opportunities, and threats to educational institutions. While the opportunities come from the economic and technological development and can result in many great ways for these institutions to improve their activities, the challenges that universities face, force them to adapt their resources, academic programs, the investments they make in research, and other items, so that they may be able to continue to operate within the environment. All the elements mentioned above stand for the mission of a higher education institution (de Jager, 2001), and are supposed to be considered when designing the mission statement, so that they become part of the organizational culture of the institution and be embraced and implemented by its employees. [2]

The COVID-19 has revealed emerging vulnerabilities in education systems around the world. It is now clear that society needs flexible and resilient education systems as we face unpredictable futures”. [3] Universities were forced to close their physical campus, change their strategies/processes/infrastructure/culture, and perform digitally. The arising question from this change in paradigm is whether the changes to the university system were: (a) digital transformation or (b) IT adaptation. The purposes of this research are: a) to propose an exponential

systemic universities digital transformation model with emphasis on the development of stakeholder competencies, and b) to identify gaps in the implementation of the digital transformation in Latin America universities.

2. Digital Transformation or IT Adaption

According to Brooks and McCormack [4] there are three stages of digital transformation: Digitization, Digitalization and Digital Transformation. Digitization is simply an IT adaption where the physical documents are changed to digital form. The second stage is digitalization, also an IT adaption where the individual processes adapt with technology. The last stage is digital transformation. According to Brooks and McCormack [4] “Digital transformation is a series of deep and coordinated culture, workforce, and technology shifts that enable new educational and operating models and transform an institution’s operations, strategic directions, and value proposition.” (p. 5). Due to its relationship with the strategic objectives of the organization, digital transformation is considered a strategic process.

Indriasa, Harso Supangkat and Kosala [5] also emphasizes on the same elements of digital transformation: culture change, structural change, technology adaption and value creation. To enhance the digital process, their theory adds the joint process of IT governance and business organizations. Therefore, the other element of digital transformation is IT functionality.

Kaarianen et al [6] discussed four levels of digital transformation: process, organization, business domain, and society level. Where the first two stages are digital adaption of manual process and implementation of technologies, the next two are digital transformation. Digital transformation is the significant shift in the ecosystem and “society structure” that will transform decision making.

Digital Transformation requires innovation that has “disruptive change”. According to Sehlin, Truedsson and Cronemyr [6], it starts with enhancing core activities, exploring new opportunities and transformational innovative ventures. Also, Fuch and Hess [7] indicates that radical change is a key element during the transformation process and is affected by the barriers of change.

3. Exploring the Implications of the Digital Changes within the University Environment

A documentary analysis [8] was carried out based on reports from different Spanish institutions to reflect on the results of the different types of assessments used by some European and United States universities to face the beginning of the Covid-19 pandemic between the months of March to June 2020. Among the European countries are Germany, Austria, Belgium, Denmark, Ireland, France, Italy, Portugal, Sweden, United Kingdom, and Netherlands. The results showed that the emerging remote education caused by the pandemic requires an appropriate design for evaluations according to the context and not a simple transposition of an education traditional online that had been developing in some universities prior to COVID-19.

Technology has been and is a great ally in this urgent unplanned virtualization; however, other variables must be considered. Sociability, heterogeneity of students, and the assessment model must be analyzed without forgetting the basic quality characteristics of an online education such as variability, progressive activities, time organization, offer of individual and group activities, clear rules, and specific types of evaluation. According to the results, most European countries have sought the diversity of their evaluations based on continuous evaluation as the most recommended, online questionnaires, assignments, oral exams, homework, video conferences and opening possibilities for face-to-face evaluations. Proctoring is an assessment model that has not been widely used or recommended during the pandemic due to the disadvantages it has, mainly with data protection, because it is very invasive and because of the demands on continuous

internet connections. Proctoring is the “remote surveillance during an online exam, including biometric analysis and suspicious use of the computer”.

Ramirez-Montoya’s study used an applied methodology of multiple case studies with an instrumental approach in ten countries in Latin America [9]: Argentina, Chile, Colombia, Costa Rica, Ecuador, Mexico, Peru, Dominican Republic, Uruguay, and Venezuela presents the challenges of digital transformation (virtualization, training, infrastructure, connectivity, culture, management, open education) and educational innovation (new processes, products, services, knowledge, and research) that affected universities in these countries. Responses were gathered after an interview in depth with representatives from one university in each country. To question what the main challenges were that universities faced with COVID-19, main conclusions were concentrated in most of the countries on the socio-economical limitations in a large group of the student's population to access internet and devices. Additionally, the overwhelming effect on faculty and students, and the short time to adjust to the changes, as not all teachers were prepared to work online with their students.

On the question of what digital transformation challenges the university will have as students return to campus, it was answered that they are several related to faculty: training in technological tools, improving the skills in digitalization, improving technological infrastructure, and adequation for working in campus. It is a need to respond quickly to students and faculty demands as production of materials, platform service. A challenge is an availability for incorporating different tools for natural sciences and engineering subjects such as simulators (ex. virtual microscopes). There is a need for innovation in teaching methods, but also it is important to be aware of free software, privacy policies, protection of personal and digital literacy. Interestingly, one of the respondents highlighted the lessons learned during this first semester, mentioned that the four axes for sustainable critical digital transformation are: pedagogy of care, open technologies, collaboration, and open education.

4. Methods

The methods on this study combined several on each purpose: a) a mixed documentary and qualitative study, in the approach to the exponential systemic university digital transformation model, and the next step, b) projective qualitative-quantitative mixed study in the determination of gaps, according to the sources of information and analysis model.

5. Results and Discussion

From literature analysis, web conferences, expert analyst, and research discussions, it was proposed an Exponential Systemic University Digital Transformation Model (Fig. 1). This model includes a) external actors like governance, for regulation; accreditation agencies, for quality and employers, for professional expectations, and b) internal actors from operative to strategic level, and education, research, and administrative areas, especially information technologies.

Digital transformation, as indicated in the review of literature above, requires the deliberate change and shift in the paradigm of the universities. The university needs to innovate in the following areas: digital technologies, processes, programs, organization, and culture. The pandemic is seen as catalyst to the digital adaption and transformation at the university level. The model focuses on 5 perspectives: Students, Faculty, Management, Employers, and Accreditations. Many of the University functions that were identified to be addressed during the digital transformation process were Academic Management, Administrative, Program Design, Teaching Methods, Evaluation Methods, Digital Skills/Competencies, and Infrastructure. The data will be triangulated by receiving feedback from the students, employers, and accreditations.

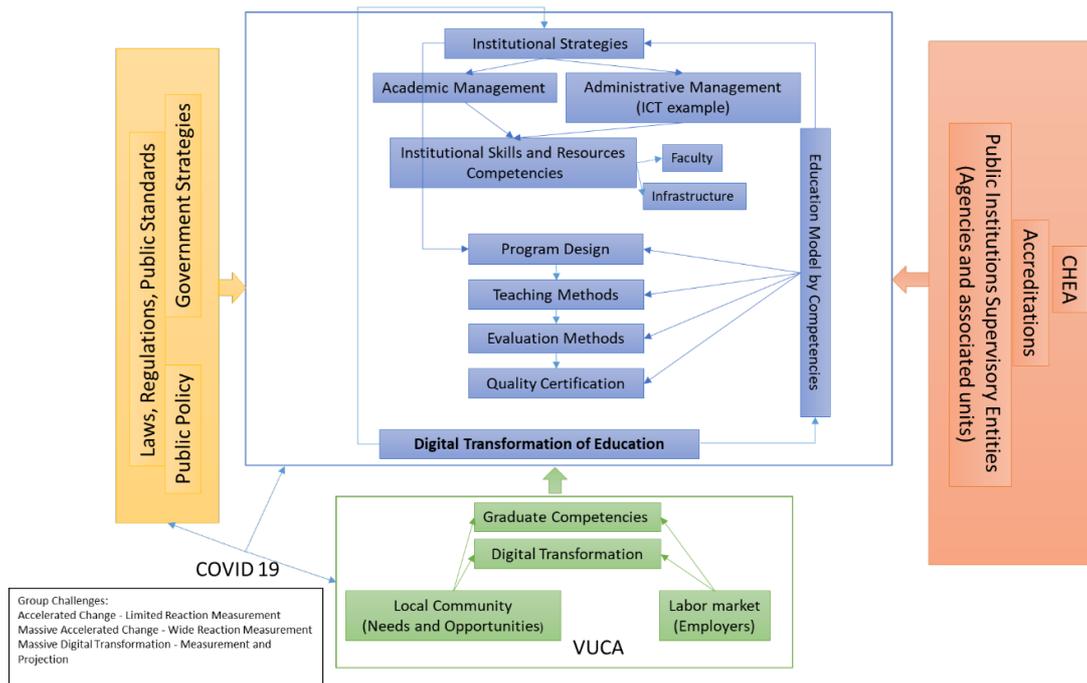


Fig. 1. Exponential Systemic University Digital Transformation Model

Digital transformation is a process of strategic transformation, built on two main fundamental bases; First, identify the dimensions of a company's digital transformation. Secondly, multidimensional pre-digital (information and communications technology) transformation assessment. After thorough review of the literature of IT adaption and digital transformation, the General GAP model (Fig. 2). was developed. The model is based on three main and sequential lines of thought, namely: the identification of digital transformation dimensions of a company, the multidimensional pre-digital transformation evaluation (i.e., information and communications technology adaption), and the establishment of a multidimensional digital transformation process.

To understand the pre-digital transformation stage, by identifying the maturity level of a company's information and communications technology usage, the researcher will develop a questionnaire and implement it in the next stage of the research.

6. Conclusion

In a VUCA context, universities require VUCA strategies with Agile Digital Transformation, universities must anticipate actions for implementation of disruptive changes, to be reactive is not enough. Digital Transformation Universities 2020 could be an agile approach or simply surviving with digital technologies without upgrading, it could be minimum viable services and products but without stakeholders' participation. So far, the gaps have not been identified since we are in the process of implementing the model.

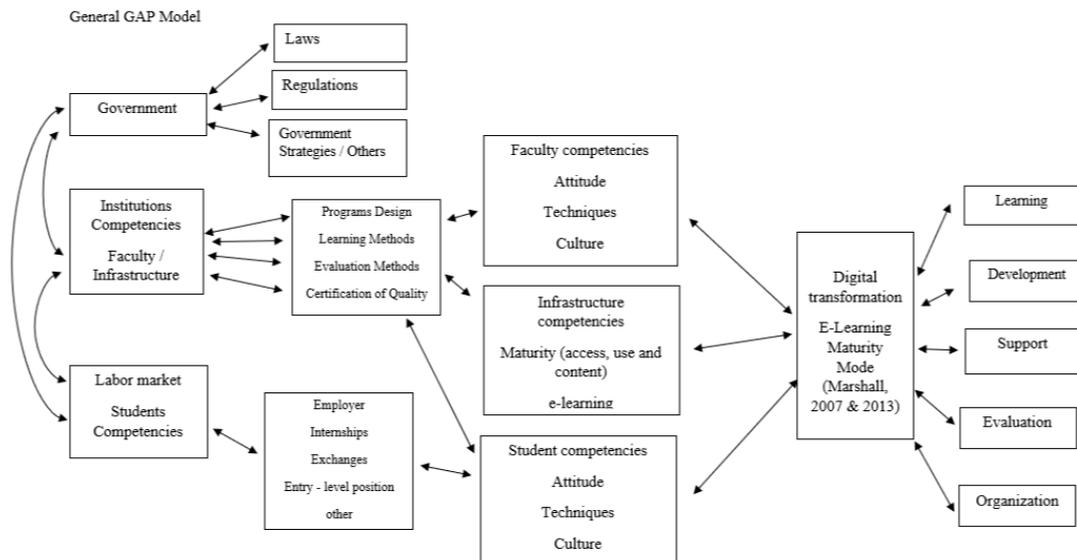


Fig. 2. General GAP Model [10] [11] [12] [13]

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SOFTWARE IMPLEMENTATION OF METHODS FOR OBJECT RECOGNITION AT PRODUCTION SITE

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Abstract: *The main component of the security system of modern industrial production is the implementation of personal protection standards for personnel. To prevent injuries at work, it is proposed to use a machine vision system, which in real time allows you to determine the presence or absence of a certain set of elements of personal protection. The technology for recognizing objects of a certain class in a video stream is proposed, which is based on a combination of the Viola-Jones method using Haar characteristics and the AdaBoost learning algorithm. The machine vision system is developed that allows the recognition of objects of a given class: mask, helmet and goggles in a person working in production in real time in video streams with a high degree of recognition.*

Keywords: machine learning, computer vision, machine vision system, object recognition, OpenCV

1. Introduction

Today, in modern production, the problem of creation of healthy and safe working environment is a part of the commercial success of the enterprise. The main task of the occupational safety engineer at the enterprise is to study the production situation and its analysis from the standpoint of safety, to identify the so-called situations of "threatening dangers" when a person and industrial danger are in contact. In this regard, the automation of control measures for safety of working conditions is a priority for modern industrial production.

One of the components of the workplace safety system is the use of personal protective equipment by personnel, which allows to counteract harmful and dangerous factors that affect the health of the employee. It is proposed to use a machine vision system, which in real time makes it possible to determine the presence of a certain set of elements of personal protection. Quarantine measures in the context of the COVID-19 pandemic also require strict adherence to the regime of personal protective equipment, including production. The most common solution is to keep a mask regimen.

Quarantine measures require the use of recognition systems in places with large crowds. Today, the most popular are the following systems recognizing faces in masks and without them: Xeoma Mask Detector PRO [1], Aerialtronics Face Mask Detection Software [2] and, Hikvision Mask Detection [3]. These systems have certain disadvantages: high cost, difficulty in use, the need for powerful hardware resources, insufficient performance and reliability of results in the absence of light, and, most important, the inability to use these systems in production.

The task was to develop software that allows you to recognize the presence of objects of a certain specified class: masks, helmets and goggles on a person working in production in real time in video streams.

The aim of the work is to develop a machine vision system used at a working place, which works in real time in video streams with a high degree of recognition and which solves the problem of recognition of employee's personal protection items: a mask, a helmet and goggles. The system uses the technology of object recognition in the video stream, which is based on a combination of the Viola-Jones method using Haar characteristics and the AdaBoost learning algorithm. As the result, two separate classifiers are used for recognition: the classifier of a positive object, i.e. the presence of a medical mask, a helmet and goggles at the same time, and classifier of a negative object, i.e. absence of one, several or all elements of personal protection. Thus, the machine vision system has been developed that allows real-time video streams with a high degree of recognition to recognize class objects: masks, helmets and goggles.

2. Statement of the Problem of Object Recognition in the Video Stream

We formulate the problem of object recognition by the machine vision system as follows: a video image is given, to select and determine the presence of a certain set of objects on a person's face. Currently, in the field of machine vision, there are two separate tasks: the detection of objects of a given class in the image and the recognition of certain objects in a sequence of images (or video) [4]. The object recognition in video has certain limitations: a significant change in lighting, angle of observation, resolution: observation systems, the size of the field of view.

Detecting objects in a video can be reduced to the task of detecting objects of a certain class in a static image. In this case, as a rule, the problem of object detection is considered as a binary classification problem: the classifier trained on the test data decides whether the image belongs to the desired class [4]. Such algorithms have a higher rate of accuracy and reliability of the definition of the desired objects.

Currently, there are many methods of recognizing objects in the video stream, which have their advantages and disadvantages [5-9]: AdaBoost, AnyBoost, Viola-Jones, based on artificial neural networks.

In the work was decided to implement the technology of recognizing objects of a given class based on the Viola-Jones method using the characteristics of Haar and building a cascade of classifiers learned using the AdaBoost algorithm.

3. Description of Object Recognition Technology in the Video Stream

Real-time information technology should solve the following tasks:

- identification of objects of specified classes in the frame (the presence of a medical mask, helmet and goggles at the same time);
- determining the absence of one, several or all items of equipment.

To solve the definition of objects, it is planned to use an approach based on the Viola-Jones method using the characteristics of Haar and training classifiers using the AdaBoost algorithm. The technology of recognition of objects of a given class in production proposed in this work consists of the following stages (Fig. 1).

Stage 1. Obtaining input data.

Get a frame from a video stream or read an image.

Stage 2. Validation of the received frame.

If the frame was received from the video stream, then set the flag to true, which signals the successful reading of the frame, otherwise – false.

Stage 3. Convert the resulting frame to the desired format. Perform the conversion of the resulting frame to the desired image file format using the appropriate conversion type.

Stage 4. Classification of objects in the read frame (application of the Viola-Jones method using Haar characteristics and training of classifiers using the AdaBoost algorithm).

Stage 5. Display of recognition results. We process the results of the classifier: draw a rectangle of green (for correct objects) or red (for incorrect) in the frame, and write the appropriate text.

Stage 6. Display the resulting image on the screen in a separate window.

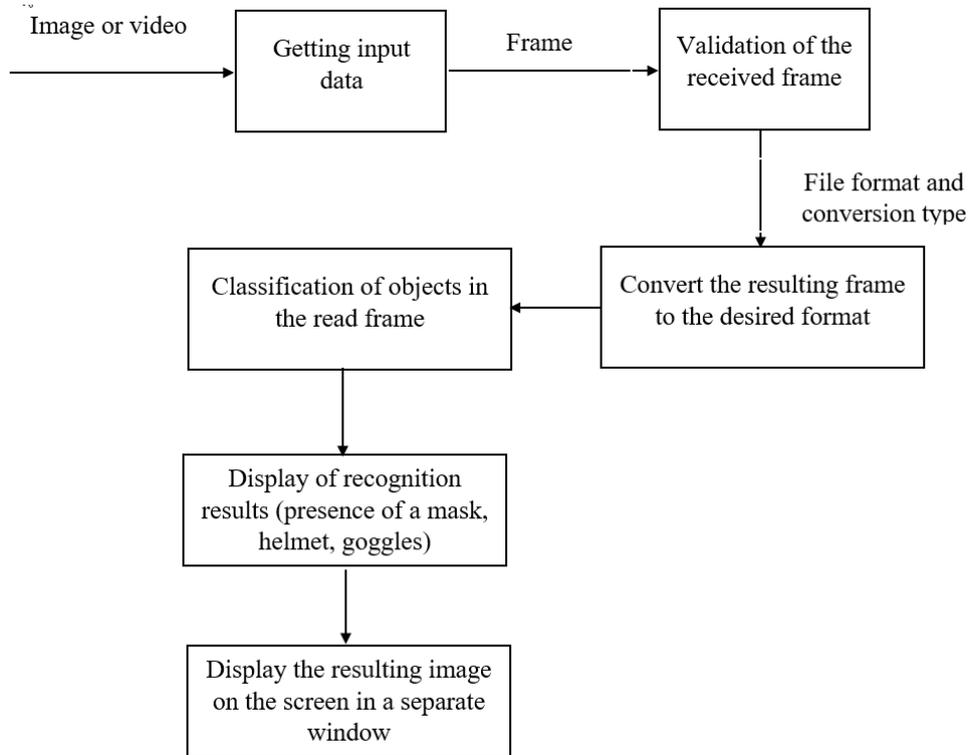


Fig. 1. Technology for recognizing objects of a given class in production

The technology that allows to recognize objects in production is described. To implement the technology in the form of a machine vision system, it is necessary to implement and investigate cascade classifiers that will recognize "correct" objects: in this context, the problem is a person who physically has a mask, helmet and goggles, or recognize "incorrect": this is, on the contrary, a person who does not have any of the elements.

The Python programming language and the OpenCV open source computer vision library were chosen to implement the systems. There is no need to develop a visual user interface for this system, as the program is only an implementation of technologies that solve certain problems of computer vision and can be used in other software systems. Therefore, to demonstrate the ability to recognize objects of a given class: masks, helmets and goggles in humans were solved using the built-in OpenCV function, which allows you to receive images using webcams, files and its output to the screen.

The problem of recognition was solved in the work: positive (correct) object and negative (incorrect). To do this, perform training of 2 separate classifiers. One will recognize the correct object (the presence of a medical mask, helmet and goggles at the same time), the other - the wrong one (missing one, several or all items of equipment).

4. Experimental Study of the Developed System

The developed system solves the problem of recognizing objects of a given class in real-time production in video streams.

The developed system has the following functionalities:

- search and detection of the presence of a blue medical mask in humans on video footage;
- tracking of a white helmet and yellow glasses at the employee of the industrial enterprise on consecutive shots of video recording;
- perform recognition of objects of a given class from any convenient angle of the camera on the left or right in the aisle.

The developed system was able to solve the described tasks in real-time mode efficiently on streaming video with the speed of work at no less than 30 frames per second.

The examples of work results of developed system are given below. The result with the presence of a medical mask of blue color in humans is shown in Fig. 2. Tracking the medical mask of blue color and yellow goggles in the employee is shown in Fig. 3.

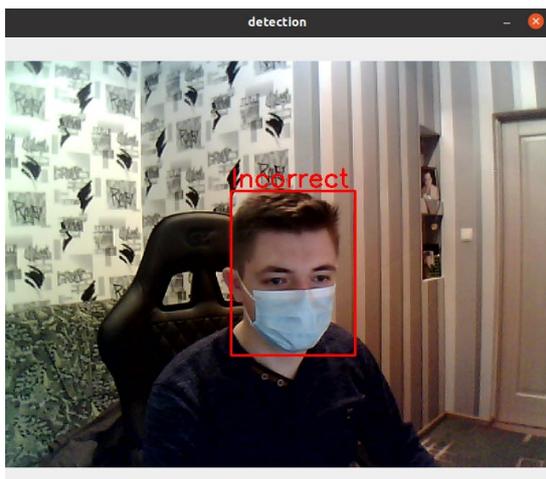


Fig. 2. The result in the presence of a blue medical mask on humans

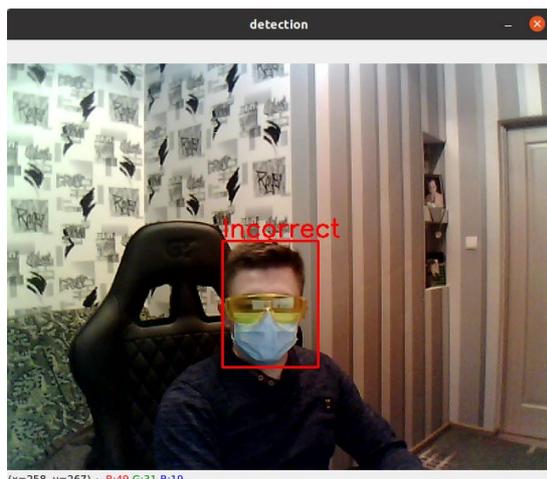


Fig. 3. Tracking the blue medical mask and yellow goggles of the employee

The result in the presence of a white helmet for the employee is shown in Fig. 4. Fig. 5 shows the result of the program in the presence of a white helmet, a blue medical mask and yellow goggles for the employee.

Comparative analysis of the functionality of the system with known analogues. Of the known analogues that implement technology similar to that developed in this work, we can note the following systems: Xeoma Mask Detector PRO, Aerialtronics Face Mask Detection Software, and Hikvision Mask Detection.

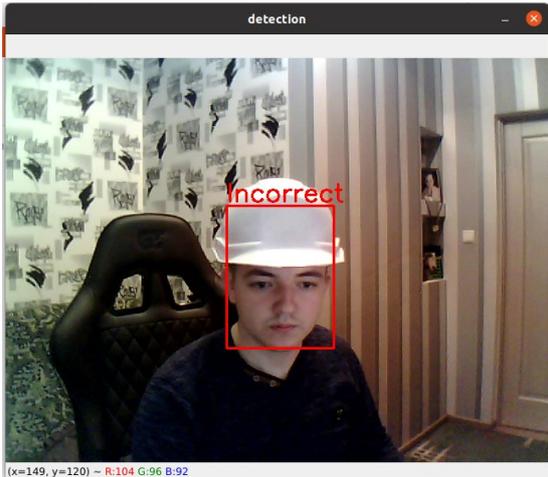


Fig. 4. The result in the presence of a white helmet on the employee



Fig. 5. The result in the presence of a white helmet, a blue medical mask and yellow goggles on the employee

The comparison of the functionality of existing analogues of systems for recognizing objects of a given class in production and the developed system is given in Table 1.

The essence of the experiment is to compare the capabilities of analog systems and the developed author's system to detect personal protective equipment: medical mask, helmet, goggles, as well as additional criteria the ability to work in real time and portability and portability.

TABLE I. Comparative Analysis of Systems for Recognizing Objects of a Given Class in Production

Systems \ Parameters	Xeoma Mask Detector PRO	Aerialtronics Face Mask Detection Software	Hikvision Mask Detection	Developed system
Search for a medical mask	+	+	+	+
Helmet tracking	-	-	-	+
Goggles tracking	-	-	-	+
Work in real time	+	+	+	+
Portability	-	-	-	+

Based on the analysis, it can be concluded that the developed system, in contrast to existing analogues, allows to determine the presence of a blue medical mask in humans, and also solves the problem of determining a white helmet and yellow glasses in an industrial worker in real time on video.

Evaluation of the reliability of recognition. A number of experiments were performed to assess the reliability of the recognition of objects of a given class in production using the developed technology. During which the dependence of the recognition indicator on the conditions in which this indicator is calculated was established. The recognition indicator is affected by the following parameters: the quality of the illumination of the working area, the angle of video recording and the physical distance from the video device to the potential object of recognition.

The essence of the experiment is to compare the ability of the system to detect objects of personal protection in different lighting conditions, camera angles, distances, as well as additional criteria, calculating the number of correctly recognized objects - the recognition index.

To accurately describe the above dependence, the results generated by the system during the processing of 1000 static images in different conditions were investigated. The results of the experiments are shown in Table 2.

TABLE II. Results of Experiments

№	Illumination, lux	Angle, degree	Distance, m	Number of correctly recognized objects	Recognition indicator, %
1	1600	90	5	153	15,3
2	5800	135	2	396	39,6
3	19000	180	1	768	76,8

The goal of the experiment was to understand the dependence of recognition rate on various factors close to ones existing at a production site. It can be shown from the Table 4.2 that the recognition indicator depends significantly on illumination rate, angle degrees, and distances. The higher these factors (illumination rate and angle degrees) are, the more accurate the recognition is.

5. Results and Conclusion

As a result of the work, the methods of recognizing objects of a given class were studied: masks, helmets and goggles in a person working in production in real time in video streams.

The following recognition systems were considered: Xeoma Mask Detector PRO, Aerialtronics Face Mask Detection Software, and Hikvision Mask Detection. The considered systems have certain shortcomings, namely: high price, difficulty in use, impossibility of use of these systems in the conditions of production, necessity of powerful hardware resources, insufficient productivity and reliability of results in the conditions of lack of illumination. Therefore, there is a need to develop software that allows you to recognize objects of a given class: masks, helmets and goggles in a person working in production in real time in video streams. The proposed solution allows getting the best results of recognition objects in the conditions of lack of illumination and can be using in production site.

The advantages of using Xeoma Mask Detector PRO include bandwidth storage and real-time image processing, the disadvantages - the cost. The advantages of using Aerialtronics Face Mask Detection Software include real-time image processing and protection of private data and privacy, the disadvantages - the need for powerful hardware resources and cost. The advantages of using Hikvision Mask Detection include the availability of various technical solutions, the disadvantages - the need for powerful hardware resources and cost.

The technology of recognition of objects of a given class: masks, helmets and goggles in a person working in real-time production in video streams, which consists of six stages, was built in the work. A study of the system development software was also performed: the Python programming language and the OpenCV open source computer vision library were selected.

The functional capabilities of the developed system were described and investigated. These functionalities have been compared with other known systems that work in the field of determining objects of a given class in a production or enterprise using computer vision or machine learning algorithms.

The number of experiments were performed to assess the reliability of the recognition of objects of a given class in production. In the course of these experiments, the dependence of the recognition indicator on the conditions under which this indicator is calculated was established. It is affected by parameters such as the quality of the illumination of the work area, the angle of video recording and the physical distance from the video device to the potential object of recognition. The results of the experiments showed a fairly good indicator of the reliability of recognition in the developed technology (76.8%).

It was also suggested that the technology could be improved by adding the Modbus TCP / IP protocol to signal the recognition results to the server.

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DEVELOPMENT OF PROJECT-BASED ORGANISATIONAL STRUCTURES TO RESPOND TO VUCA ENVIRONMENTS

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Abstract: *The crisis resulted from the impact of COVID-19 in global socio-sanitary situation has changed radically global market conditions. At present manufacturing enterprises have to cope with very unstable and unpredictable conditions, that can be framed in the namely VUCA environment. VUCA stands for “Volatility, Uncertainty, Complexity and Ambiguity” and it was first coined after the end of cold war to describe the existing unfavourable conditions at that point in time, which can be applied to current scenario. This new situation, which will last in advance more than expected, arises the need for manufacturing enterprises to gain agility and capability to adapt to these new conditions. The adoption of project-based continuous improvement initiatives, by means of Lean Manufacturing and Six Sigma methodologies, can respond to the new VUCA conditions to overcome current crisis. Therefore, the focus of this paper is to present the characteristics of a project-based organisational structure to adopt a continuous improvement approach and overcome current VUCA environment conditions.*

Keywords: project-based organization, six sigma, lean manufacturing, continuous improvement, VUCA world

1. Introduction

During the last months, world economic situation has changed dramatically due to the impact of COVID-19 pandemic. Manufacturing enterprises have been overnight forced to modify their daily routines in order to guarantee the very much needed sanitary rules and regulations, such as social distance, quarantines and cleanliness. Nonetheless, pandemic impact is not only limited to working routines and habits, as there has been a dramatic change in market conditions and customer demands. Due to the uncertain evolution of COVID-19, it becomes very difficult to make estimations about upcoming demands and productions, thus companies have virtually no time to react to the incoming orders. All this new socio-economic conditions have arisen the need for more organizations, understood as their capacity for making timely, effective and sustained change, when it results in a performance advantage [1].

In the last decades, Lean Manufacturing (LM) and Six Sigma have been the most widespread Continuous Improvement (CI) initiatives in order to gain competitive and performance advantages and obtain bottom-line improvements. There have been many different approaches to CI, but Lean Six Sigma (LSS) is the latest generation of those [2]. Six Sigma was first developed and implemented at Motorola in the mid-1980's. Initially it included only 4 phases, namely Measure, Analyse, Improve and Control. It wasn't until 1995 when General Electric, led by Jack Welch, finally included the first stage of the well-known DMAIC cycle, the Define phase. In the other hand, the concept of LM was first put into practice in Toyota and became famous thanks to the Toyota Production System book written by Taichi Ohno. Even if the concept of Lean has been around for decades, it did not get integrated with Six Sigma until the late 1990's and early 2000's [3], [4]. The purpose of combining LM and Six Sigma is that, the first seeks to eliminate waste and improve process speed, while the latter reduces process variation by means of the execution

of the DMAIC cycle. According to [5], A systematic approach to improvement is needed to improve performance as measured by quality, cost, delivery and customer satisfaction. LSS works better than previous approaches because it integrates the human and process aspects of process improvement as summarized in the table below.

Table I. Human and Process Aspects of Improvement

Human Issues	Process Issues
Bottom line focus (€)	Process improvement
Management leadership	Analysis of variation
Sense of urgency	Disciplined approach
Customer focus	Quantitative measures
Project teams	Statistical thinking and methods
Culture change	Process management

Even though the benefits of implementing LM and Six Sigma together are well documented in several case studies, there is still a subset of implementation barriers which handicap the achievement of those benefits. Currently there are frameworks and roadmaps for implementation, but there is still a lack of a robust end-to-end solution for helping enterprises overcoming the implementation barriers [6].

Historically, changes are perceived to be managed within programmes (and projects) instead of perceiving programmes (and projects) as organizations to manage changes [7]. Thus, as the implementation of LM and Six Sigma within a company is a major change, this could be managed inside the existing framework of project management. On this purpose, the present article will focus on the definition of the organisational characteristics, adopting a CI project-based organisational approach, in order to respond to the new VUCA environment conditions. VUCA stands for “Volatility, Uncertainty, Complexity and Ambiguity” and those were the unfavourable conditions existing after the finish of the cold war. Several studies support this idea of designing current situation as VUCA [1], [8]–[10], hence in the next chapters we will link VUCA features with the new environment conditions raised from COVID pandemic, as well as the most effective way to address them.

Project-based organisational structures are defined as the types of organisations that use projects in order to carry out their business. These organisations create internal temporary project teams aiming to complete the project deliverables within the expected budget, time and quality requirements. There are several types of PBO’s, depending on the projectization degree of the organisation, going from the pure project organisation to the functional hierarchy [11]. In the present article we propose the utilisation of these kind of project organisations in order to carry out the CI improvement projects. Due to the interdisciplinary nature of projects, and that this new VUCA environment is essentially applicable to all organisational levels, we believe that this type of organisation would enhance the execution and improve success rate of CI initiatives.

2. Characteristics of VUCA Environments

With the outbreak of COVID-19 pandemic, world socio-economic changed suddenly and manufacturing enterprises had to adapt overnight their production lines and operating systems. From one side, at the beginning of the crisis, thousands of on-site workers were forced to be placed on furlough due to the stoppage of production lines, or had to start with remote working. Over time, however, pandemic impact had been lowered and enterprises started reopening their production lines, amid uncertainty about the upcoming pandemic evolution. In the other side, and once the first, and toughest, pandemic wave had gone through; manufacturing enterprises have encountered a new global scenario which can be defined as a VUCA environment.

The notion of VUCA was originally introduced by the United States Army to describe the unfavourable conditions that resulted from the end of cold war, and it has subsequently adopted by business leaders across the globe to different kinds of challenging situations posed by various external factors [9]. This environment has unique conditions that, if not addressed correctly, may have a big negative impact on organizational performance and sustainability. As stated by [1], organisations were not prepared in the pre-pandemic era for the upcoming VUCA world, therefore there is a need for change in order to respond to this new global scenario. In the following table, adapted from [8], distinctions within the VUCA framework are presented and related to the current COVID environment, as well as requirements for the most effective to address each construct.

Table II. Distinctions within the VUCA Framework, Related to Current COVID Situation

	What it is	Example	How to effectively address it
Volatility	Relatively unstable change; information is available and the situation is understandable, but change is frequent and sometimes unpredictable.	Administrations regulations (opening of businesses...), travel restrictions evolution.	Agility is key to coping with volatility. Resources should be aggressively directed toward building slack and creating the potential for future flexibility.
Uncertainty	A lack of knowledge as to whether an event will have meaningful ramifications; cause and effect are understood, but it is unknown if an event will create significant change	Effectiveness of vaccines, direction of public investments.	Information is critical to reducing uncertainty. Firms should move beyond existing information sources to both gather new data and consider it from new perspectives
Complexity	Many interconnected parts forming an elaborate network of information and procedures; often multiform and convoluted, but not necessarily involving change.	Market demands evolution, customers post-pandemic consumption habits	Restructuring internal company operations to match the external complexity is the most effective and efficient way to address it. Firms should attempt to ‘match’ their own operations and processes to mirror environmental complexities
Ambiguity	A lack of knowledge as to ‘the basic rules of the game’; cause and effect are not understood and there is no precedent for making predictions as to what to expect.	COVID pandemic evolution over time.	Experimentation is necessary for reducing ambiguity. Only through intelligent experimentation can firm leaders determine what strategies are and are not beneficial in situations where the former rules of business no longer apply

3. Addressing VUCA through PBO

As stated by [12], when inflection points emerge, such as current COVID-19 crisis, uncertainty is enhanced, and change is necessary for firms to remain competitive. Therefore, this article proposes the adoption of project-based CI initiatives such as LSS as a way to respond to current VUCA environment conditions derived from COVID crisis.

Agility and the capability for a quick reaction to changes seems to be determinant in this crisis, so the adoption of LSS will aid on acquiring these organizational characteristics. Indeed, [12] sustained that agility is the key organizational feature in order to manage uncertainty. In one hand, LM is the most suitable tool for speeding up processes by eliminating waste. Moreover, the adoption of Kaizen thinking is essentially participative, entailing the involvement and intelligence of the workforce [13]. This aspect of involving staff in CI initiatives proves to be very relevant in order to obtain the benefits expected.

In the other hand, Six Sigma is a CI project methodology with 5 different phases, namely DMAIC, which aims at reducing process variation by implementing of corrective actions based on data. With the integration of the Voice of the Customer (VOC), first-hand external information could be brought inside the organisation and gather valuable data. Afterwards, the quality function deployment methodology would extend this information to the internal processes. Gathering this new external data could respond to the uncertainty created by this new VUCA environment.

Experimentation is necessary to understand the new rules and find the cause and effect relations, and avoid making predictions with little or no hope for guessing the outcome. On this issue, Design of Experiments (DOE) methodology would be of great help on finding those cause-effect relationships. As Six Sigma has a strong data-based approach, decisions will be data driven rather than on opinions, what would increase the probabilities for finding those new and unknown rules.

Project-based organisational structures have been put forward as a form ideally suited for managing increasing product complexity, fast changing markets, business expertise, customer-focused innovation and market, and technological uncertainty [14]. This kind of organisations create project teams build upon specific requirements, and are able to react rapidly to the new organisational needs. As CI projects will arise aiming to respond to new environmental conditions, and thanks to the temporary nature of project teams, the organisation would have a big restructuring capacity.

4. Conclusions

The need for change arises in times of crisis, caused by external or internal factors to the organisation, with the intention to overcome the resulting unfavourable situation. In this case, COVID crisis has highlighted the limited capability from organisations to adapt to upcoming conditions. In the first pandemic wave, organisations had much difficulties in adapting their structures to remain sustainable. Afterwards, market unstable and unpredictable conditions, is requiring high capacity to adapt to variable market demands, or even to produce new products or services. In one hand, the adoption of a CI approach in organisations may be of great help to acquire, organisational agility by means of the principles of LM. These principles can be implemented not only to speed up operational processes, but also information transfer processes. In the other hand, Six Sigma methodology enables the integration of the voice of the customer inside the organisation and adapt operative processes in order to meet customer demands. Nonetheless, the adoption of this approach requires some grade of projectization within the organisation, not only due to the temporary nature of CI projects, but also for the capacity of projects to institute change in organisations [15]. The use of temporary project teams enables organisations to gain internal restructuring capability, which seems to be a key issue in current VUCA situation. Future research direction should focus on the development of a specific framework for the implementation of this project managed continuous improvement approach.

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TRANSFORMATION OF LABOUR POTENTIAL IN DIMENSION OF DIGITALIZATION ECONOMY

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Abstract: *The paper focuses on the research of the innovative transformations that affect the development of labour potential. The future jobs in context of innovation transformations are analyzed. Top 20 job roles in increasing and decreasing demand across industries are payed attention. The influence of COVID-19 on the labour potential development in the context of current conditions are noted by authors. The changes of higher education are given under dimensions of innovation process. The consequences of transformations in higher education for the development of human potential are studied. The authors proposed the directions of adaptation of higher education system to the labour market transformations in order to strengthen the efficiency of the national economy.*

Keywords: labour potential, digitalization, higher education, innovation development, ICT

1. Introduction

Today, the prosperity of any country is determined by the skills, efficiency and attitude to the labour force that is used by this country, it is relevant to study the aspect of the development of labour potential in the context of the transformation of the innovative economy under the influence of digitalization processes.

In other words, the development of labour potential is a factor in the long-term growth of any country, and in the conditions of transformations under the influence of the 4th Industrial Revolution, the development process takes place in terms of social transformations. It is due to the fact that the majority of developed countries were able to develop not only due to the available natural resources, but also by their own will, potential and the skills of their human resources. For example, countries such as Japan, Singapore, Germany and Hong Kong have achieved "economic miracles" by mobilizing their human resources, investing in labour development, given the scarcity of natural resources.

As the diachronous analysis of economic growth shows, many countries that are poor in natural resources have been able to achieve high economic and human development at the expense of human resources. Regarding the available physical capital, it allows the country to receive higher guarantees of development, but the using of physical capital also requires highly qualified resources involved in the direct use of physical capital.

We should note that, the higher the level of education of human resources, the more labour productivity and production itself increases. First of all, the educational level and qualifications of human resources, which form the labour potential, play a key role in the production of high-tech goods.

In addition, highly qualified human resources influence and participate in the reform of traditions, culture and values in the country, emphasizes the importance of social development of labour resources of any economy.

Given that human resources are involved in increasing managerial potential and entrepreneurship, one can argue about their role in the development of innovations: new production technologies, new markets and new technologies are developing, in turn increasing production and, accordingly, national income.

So, the labour potential in modern conditions is being transformed under the prism of transformations of both the social environment and the changes that will occur in the country's economy as a whole.

The studies 'Le capital au XXI^e siècle, éditions du Seuil' of T. Piketty [1] show that innovation can increase productivity by 5 times the labour, and therefore stimulate demand within the country. However, it should be noted that in the context of researching the prerequisites for Ukraine in the long term, the key need is to increase the volume of investments in research and innovative development.

According to international statistics, worldwide investment in research and development (R&D) as a percentage of GDP increased from 1.5% in 2000 to 1.7% in 2015 and remained virtually unchanged in 2017, however, in developing countries was only less than 1% [2].

Methodological basis of the research is dialectical methods of cognition, theoretical positions of Transformation of labour potential in dimension of digitalization economy. In the process of research, the methods of comparative of modern tendencies by using the results of surveys of international organizations and companies were used. In the process of justification of the current directions of transformation of labour potential, the methods of analysis, synthesis, logical generalization, comparison, induction and deduction have been used.

2. The Future Jobs in Context of Innovation Transformations

Equally important is the analysis of the results of the World Economic Forum's research "The Future of Jobs 2020", which is devoted to up-to-date information on the labour market and employees in it in the context of the opportunities for the present and future development of the labour market [3].

The key value of this report is that the World Economic Forum is noted the emergence of a completely new labour market, within which the potential scale of crowding out of current employees is manifested due to the deepening of innovative transformations. In particular, technological automation and the emergence of completely new professions and jobs, have nothing in common with existing ones.

In particular, as can be seen from Fig. 1 the past two years have seen a clear acceleration in the adoption of new technologies.

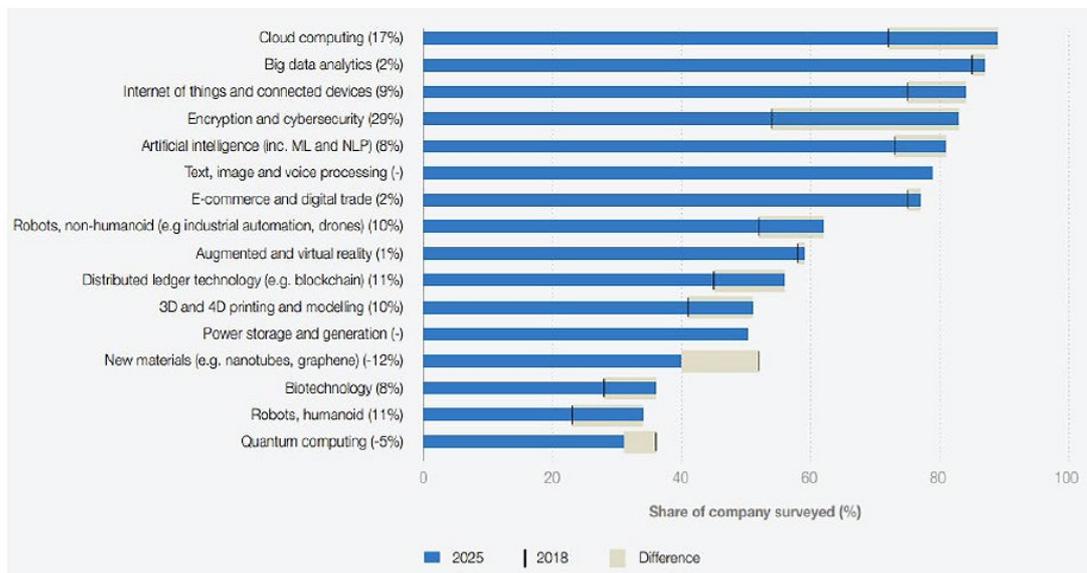


Fig. 1. Technologies likely to be adopted by 2025 (by share of companies surveyed)

This is done by using report ‘The Future of Jobs’ [3].

Fig. 1 shows the results of the survey of international companies regarding new technologies that will be adopted and implemented by them until 2025. However, it is worth noting that cloud computing, Big Data and e-commerce have remained high priorities over the past years. At the same time, we are seeing a growing demand for encryption, reflecting the new risks of the digital society and gig economy, and the introduction of non-humanoid robots and artificial intelligence, with both technologies gradually becoming the backbone of activities in various industries.

Taking into account the industry aspect, we observe that the lion's share in the industries of digital information and communications, financial services, healthcare and transport is occupied by the artificial intelligence. On the other hand, Big Data, the Internet of Things and non-humanoid robotics are becoming more common in the mining and metallurgical industries.

As for the government and the public sector, according to the survey results, encryption technology is in the greatest demand, which is associated with ensuring the national security of the country.

As a result, new technologies lead to the emergence of fundamentally new jobs, positions and a set of skills and competencies, which, in turn, affects the social development of labour potential in the context of innovative transformations and requires a response from the governments of the respective countries in terms of creating prerequisites for the transition to new realities of development and long-term prospects.

A significant amount of foreign research indicates that the introduction of new technologies will affect the workplace, displacing some of the tasks currently performed by employees, into an area of activity that, in the not too distant future, will be performed by machines. The degree of disruption to work will depend primarily on the profession and skills and competencies of the employee.

Automated algorithms and machines (work) will be primarily focused on the tasks of processing and retrieving information and data, administrative tasks and some aspects of traditional manual

work. Tasks in which people are expected to maintain their comparative advantage include: management, consulting, decision-making, reasoning, communication, and interaction.

Further, quite informative in the context of the analysis of international trends, is Table 1, which reflects the Top 20 roles in increasing / decreasing demand in various industries.

TABLE I. Top 20 Job Roles in Increasing and Decreasing Demand Across Industries

Increasing demand		Decreasing demand	
1	<i>Data Analysts and Scientists</i>	1	<i>Data Entry Clerks</i>
2	AI and Machine Learning Specialists	2	Administrative and Executive Secretaries
3	Big Data Specialists	3	Accounting, Bookkeeping and Payroll Clerks
4	Digital Marketing and Strategy Specialists	4	Accountants and Auditors
5	Process Automation Specialists	5	Assembly and Factory Workers
6	Business Development Professionals	6	Business Services and Administration Managers
7	Digital Transformation Specialists	7	Client Information and Customer Service Workers
8	Information Security Analysts	8	General and Operations Managers
9	Software and Applications Developers	9	Mechanics and Machinery Repairers
10	Internet of Things Specialists	10	Material-Recording and Stock-Keeping Clerks
11	Project Managers	11	Financial Analysts
12	Business Services and Administration Managers	12	Postal Service Clerks
13	Database and Network Professionals	13	Sales Rep., Wholesale and Manuf., Tech. and Sci. Products
14	Robotics Engineers	14	Relationship Managers
15	Strategic Advisors	15	Bank Tellers and Related Clerks
16	Management and Organization Analysts	16	Door-To-Door Sales, News and Street Vendors
17	FinTech Engineers	17	Electronics and Telecoms Installers and Repairers
18	Mechanics and Machinery Repairers	18	Human Resources Specialists
19	Organizational Development Specialists	19	Training and Development Specialists
20	Risk Management Specialists	20	Construction Labourers

According to the survey results, employers expect that by 2025 the number of re-roles will decrease from 15.4% to 9% (a decrease of 6.4%), and new professions are growing from 7.8% to 9%. 13.5% (up 5.7%) of the total headcount of the responding companies [3].

Based on this figure, analysts of the World Economic Forum predict that by 2025, 85,000,000 jobs could be witnessed through the redistribution of labour between humans and robots, 97,000,000 new roles could become the habitat, most of which are present in a new division of labour among humans and automated methods.

Thus, summarizing the global trends in the development of the labour market, key features should be highlighted, in particular: active introduction of new technologies; the emergence of new jobs that are fundamentally different from the existing ones and the reduction of the latter; new skills and competencies instead of outdated ones. Some of these tendencies should be taken into account

when forming the organizational and economic mechanism for the social development of the labour potential of Ukraine.

In addition, it should be noted that despite the significant impact of the Fourth Industrial Revolution on the development of labour potential of the world economy in general and Ukraine in particular, as evidenced by the above analysis of global trends, there is a current phase of decline caused by the COVID-19 pandemic. As a result, the shutdown of the processes of high-quality structural amenities in the economies of the countries of the world is displayed in the context of innovative transformations. Therefore, when developing an organizational and economic mechanism should take into account the state of the global environment of labour potential of Ukraine. According to which the most relevant is how automation and increase human labour can affect the current number of employees and under what conditions the world labour market can be balanced view of a new balance between workers and automated algorithms (machines).

Technological declines, which in previous periods were characteristic only of developing countries, including countries with a transit economy to which Ukraine belongs, are now intensifying in these countries, in connection with the recession of COVID-19 began to occur in part and in developed countries.

In this context, for the first time in recent years, job creation is beginning to lag behind the disappearance of the obsolete. The enterprises are set to accelerate the digitalization of work processes, training, expanding opportunities for remote work, as well as automation of tasks.

3. Labour Potential in the Context of Transformation of Higher Education in Modern Conditions

Taking into account the important role of higher education in shaping the level of qualification of labor potential, it is appropriate to pay attention to the transformations that are inherent in the tertiary sector in the prism of the digital economy.

Qualitative transformation of higher education in modern conditions:

- Application of the competence approach
- Possession of skills of use of modern information and communication technologies
- Active introduction of interactive teaching methods
- Interdisciplinary approach (acquisition of knowledge within several industries / professions / specialties)
- Robotics and robots: the disappearance of professions or changes in the content of work in many traditional specialties
- Internet of things, smart technologies - make learning and life convenient, fast, mobile and creative
- Development of human qualities: empathy, sociability, values, teamwork
- Activation of the functions of socialization and social inclusion.

Given the important role of higher education, we consider it appropriate to pay more attention to the modern challenges and realities of higher education transformations, in particularly:

- transition to distance learning;
- growth of information overload;
- unwillingness of certain categories of teachers to work online;
- digital divide (access, using of ICT, digital skills);
- Internet congestion during peak hours;
- imperfection of local distance learning systems;

- lack of effective time management skills among participants in the educational process;
- the complexity of competition with the world's powerful universities;
- strengthening differentiation in terms of educational activities in terms of regions and countries;
- complication of practical training by students in terms of quarantine;
- after the completion of quarantine measures, the higher education systems of many countries will be significantly transformed taking into account the experience gained.

Taking into account the above challenges, it is logical to ask how the higher education system should react to the labour market transformation.

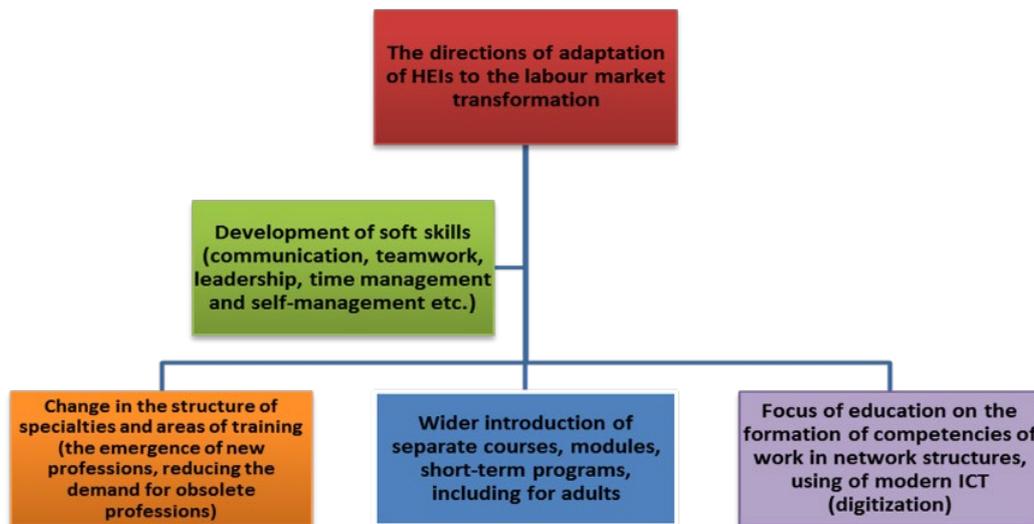


Fig. 2. The directions of adaptation of HEIs to the labour market transformation

Accordingly, it is advisable to suggest the following areas directions of adaptation of HEIs to the labour market transformation as a subject of higher education system (Fig. 2).

It is the active position of HEIs (universities) that becomes the key from the standpoint of labour potential development at the current stage, because it acts as a producer of highly qualified personnel, which, in turn, is the basis of innovative development of any economy in the long-term.

4. Results and Conclusion

Thus, the analysis of the social development of labour potential of Ukraine in the context of innovative changes in the international environment shows the presence of radical changes aimed at redistributing the existing labour market towards new jobs, in some cases absolute human replacement by machine (robot), deepening innovation and robotization and increasing the importance of intellectual work.

At the current stage of development, Ukraine must make transformational changes, taking into account global trends, which, in turn, will strengthen the competitiveness of the economy by increasing labour productivity. A negative aspect of the active introduction of new technologies and dissemination of research and development is the pandemic, which not only directly affected and continues to affect the qualitative and quantitative composition of labour potential, but also

the need to allocate significant costs to combat its consequences. Therefore, in the process of development and subsequent implementation of the organizational and methodological mechanism of social development of labour potential, it is necessary to take into account all modern aspects of development to avoid the emergence of possible risks.

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HEALTH MONITORING FOR DIABETICS WITH A SOFTWARE-INTENSIVE SOLUTION

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Abstract: *Nowadays, with huge development of technology everything is connected to technology. Therefore, many previously hard tasks can be done as easy as possible with technological elements. In this respect, we must mention health monitoring related tasks. These tasks have more importance than the other ones, such as traffic control. As long as health is directly related to human. Without a healthy society, all the other aspects will be ignored. Hence, we must try to connect health monitoring to technology and smart homes. In many conditions, we see that a diabetic person faces Hypoglycemia and Hyperglycemia. These are just one percent of problems related to diabetics, when they cannot control their blood sugar amount. All of these things can be done with smart homes and technology to lower the problems of diabetes. In this paper, we try to think about a solution to make the lives of diabetics easier and with the least possible problems.*

Keywords: diabetics, smart home, health monitoring

1. Introduction

To start with, it is better to have a definition of diabetes disease. Diabetes is a disease related to blood sugar level of body. The blood sugar level of body in normal people -without diabetes- are being controlled automatically. In high blood sugar conditions, body itself make it lower and vice versa. However, in diabetic people, this condition barely happens [1]. Body itself controls blood glucose (sugar) using a hormone called insulin. Diabetes has two main types: type 1 and type 2. Insulin is completely unavailable for diabetes type 1 and that is hardly available for diabetes types 2 [2]. Even for diabetes type 2, controlling blood sugar level during days and nights are a tough job and diabetics may face high blood sugar level called Hyperglycemia or low blood sugar level Hypoglycemia. These problems not only will harm diabetics' body, but they will also have very bad consequences in long time occurring [3].

Diabetes is a sickness, which can affect human lives in a dangerous way. This sickness is the seventh cause of death in Australia. Furthermore, this estimate is nearly in USA, UK and many other developed countries [4]. Therefore, it can be considered as a real problem, which each day many people struggle with it. For instance, we can mention Hypoglycemia and Hyperglycemia. Hypoglycemia in easy words is a condition in which the diabetic person have less amount of blood sugar than it is needed for him/her [5]. The other problem is Hyperglycemia, which means having higher amount of blood sugar (usually after meals) than it is needed [6]. These problems are just a few problems, which can endanger diabetic people's lives. The effects of these problems can also lead to other greater problems in the future. Hyperglycemia, when occurred for many times during long times, will lead to increase the risk of post-surgical infection [7]. To reduce the problems occurring to diabetic people, there are many medical solutions, which are not the topic of our paper. On the other side, we want to make a connection between technology or Software-Intensive Solutions and diabetic people to make their life and their family's life better.

This paper starts with Motivation of the paper and its idea. Secondly, we will try to mention and clarify three main purposes of the paper. Afterwards, we will discuss each three purposes and suggest solutions to them. The last part of this paper will be the conclusion part.

2. Motivation

As mentioned earlier, diabetes is a dangerous illness, which with good control on body elements might be a normal sickness [8]. Therefore, controlling it plays an important role to be a healthy diabetic person. On the other hand, one of the researchers of this paper is a diabetic person and completely know the challenges of this illness. He has struggled with its problems for a couple of years and knows that even with the controls it is possible to face consequences of Diabetes. Consequently, we want to suggest a Software-Intensive Solution to reduce Diabetes's problems. Furthermore, with the fast speed of technology development and promotion of technology-based living, people tend to do their tasks from home and not move much. On the other hand, food ingredients are less organic, and this can also cause a set of problems in human's diet. Diet and Movement are two main things, which can help diabetics to have a healthier life and to face less problems [9].

The statement of research problem. How can we provide a Software-Intensive Solution to reduce Diabetes's consequences and make controlling of diabetes easier?

The Purpose of the paper is to try to bring three main features to diabetic people's life: 1. Make Hypoglycemia and Hyperglycemia not happen or happen very rarely. 2. Establish connection between Software and diabetic people's family or friends to reduce consequences of occurring problems of diabetes and to make informing family of diabetic people easier and faster. 3. Track diabetic people's life, health and lifestyle and make suggestions to experience a better life.

3. Importance of Mobile Diabetes Monitoring System

S. Okazaki et al. conducted a study to evaluate how Japanese physicians felt about mobile diabetes monitoring and how well they accepted it. A questionnaire based on a mobile diabetes monitoring system was conducted. The purpose of this system was to control glucose, blood pressure, weight and keep a track of physical activity, medication and insulin along with diet [10]. Result of the study showed that even though 25.9% were aware of the functions of this system, only 0.8% of the respondents used mobile diabetes monitoring previously whereas 73.2% were not educated enough about it. The effect of multiple constructs like net benefits, subjective norms, privacy, and security risks were compared along with control variables like age, experience, gender. Net benefits which is a combination of Ubiquitous control and health improvement seem to positively influence the decision in using this system. Also, same was the result for the subjective norms. However, privacy and security risks did not have any effect on this which seems to be surprising as respondents were not much concerned about it. This low concern might be because of the less technology literacy among the physicians, or they have vast experience in using the innovative medical devices. Lastly, the control variables (age, experience, gender) had no effect except for the age which had a negative influence. The younger generation was more willing to use the monitoring system as they are more familiar with technology as compared to the older generation. This study was done to make physicians understand the importance of mobile-based health care systems. Diabetes is a common condition in most developing countries hence it requires constant tracking to avoid consequences like deaths [10]. In 2019, World Health Organization reported that diabetes caused an estimated 1.5 million deaths [1].

4. Monitoring Health Related Quality of Life in Adolescents with Diabetes

Monitoring adolescents' health-related quality of life (HRQoL) in clinical practice is becoming more common, particularly in chronic conditions. A research was conducted to find the most suitable questionnaires that could be used in adolescents with type 1 diabetes. For this, total nine questionnaires categorized into generic and diabetic specific were evaluated. Generics measures of HRQoL allow us to make comparisons with the healthy individuals. While disease-specific

measures of HRQoL are suitable for the patients diagnosed with a particular disease, but they have the advantage of being more fitting to patients and can detect clinical changes better [11]. Preferably, combining both disease-specific and generic questionnaires is utilized to give a complete evaluation of the adolescent's HRQoL [12].

Out of the total nine questionnaires, the two of them; The PedsQL and the KINDL-R, having generic model seem to be more suitable for the assessment. These questionnaires are not designed to detect psychological disorders such as depression, anxiety or eating disorders but the HRQoL assessment is likely to aid in the diagnosis and discussion of psychological problems related to diabetes, as well as guiding decisions on whether to refer to a mental health specialist if necessary. In busy clinics, clinicians view the time required for assessment and discussion as a barrier to implementing HRQoL monitoring. Supervising these generic and diabetes modules can be time consuming for example, the PedsQL module takes about 20 minutes on average. So, computer-automated monitoring could be faster and save the time. The research concluded that given the multidisciplinary nature of most paediatric teams, exchanging HRQoL data as part of ongoing clinical treatment is critical and can aid in providing treatment that is tailored to the needs of the adolescent with diabetes [11].

5. Connection Between the Software and Diabetic Person's Family and Friends

One of the most dangerous consequences of diabetes when facing hyperglycemia or hypoglycemia is passing out and unconsciousness [3]. In other words, when the blood sugar level gets too high or too low, the diabetic may pass out. This will get problematic when no one is with the diabetic person. Therefore, there must be a tool to inform diabetic people's family and friends to the diabetic people themselves.

A research conducted in 2017 emphasized on the usefulness of IOT based systems in the diabetes management. It proposed a three layered IoT based framework for diabetes management. The first tier includes the wearable Wi-Fi devices which monitors heart rate, glucose, physical activity. The second tier consists of decision support, short-term risk analysis, and control algorithms. Decision support tools, long-term risk analysis and incorporation of data into the electronic health record (EHR) are also included in the third tier [13].

Another study conducted on work performed within REACTION project which focused on the development of health care service platform supporting diabetes management. The Glucose Management System application was developed within a REACTION project. Its aim was to calculate the required insulin dose based on variables such as glucose levels, dietary intake, drugs administered, and the patient's insulin sensitivity [14].

6. Track Diabetic People's Life and Suggest Ideas to Them

Previously, applications for type 1 diabetes mellitus (T1DM) and type 2 diabetes mellitus (T2DM) have been developed. Several Android and Apple applications claim to conduct all required calculations; however, the US Food and Drug Administration (FDA) or other such authorities have not approved the majority of these applications [15]. Below are some of the applications listed for patients with T1DM and T2DM. Even though there are many diabetes control applications available, only a few of them are built to help T1DM patients calculate their insulin dose.

- ***Intelligent Diabetes Management (IDM), University of Alberta.*** This application was developed by University of Alberta in 2014. This app contains a glucose and meal tracker that keeps a comprehensive record in the form of a diary. There is a website linked

(<https://idm.ualberta.ca>) which presents data like insulin dose, planned physical activity, carbohydrate intake, hypoglycaemia, etc [15].

- **Glucose Buddy.** Through this application, users can keep the track of their glucose level by entering data like their meal intake, insulin dose and physical activity. In addition, the patient may keep track of carbohydrate intake as well as other nutritional factors including fiber, fat and salt [16].

The number of people with T2DM is rising at an alarming pace around the world today. This form of diabetes is much more common than type 1 diabetes, and it mostly affects adults. T2DM is treated with a combination of lifestyle modifications, oral and subcutaneous antihyperglycemic agents, and insulin [15].

- **Bant2:** This app just like others also help user keep track of food intake, glucose level but few shortcomings of this app are 1) Can't track the calorie intake which is achieved by taking picture of the food, 2) healthcare providers don't have the access to the data, 3) not very motivating [17].
- **Diabetes Pal.** This application is available on both android and IOS. This app just like other applications mentioned above enables user to monitor their blood glucose measurement by entering the glucose measurement manually or by glucose meter via Bluetooth [15]. However, entities like calorie intake, physical activity, lifestyle, hypoglycaemic episodes, and body weight aren't tracked. [14].
- **BlueStar.** In this app, the diabetic patients can enter their glucose level (can be done manually or wirelessly) and get real-time coaching. Blood pressure and body weight are also taken into account. The user also has an option to organize their medication plan and get advice on their diet and lifestyle [15].

Previous studies have shown that results of monitoring glucose control through diabetes self-management (DSM) apps have been positive [18], but the failure rates have also been high because the users had difficulties when interacting with the apps. Hence, this shows that usability also plays a factor in the success of the applications [19]. According to LeRouge and Wickremasinghe, just 18 DSM apps had a user-centred interface [19].

7. Hypoglycemia and Hyperglycemia as Two Main Problems of Diabetes

As mentioned earlier, Hypoglycemia and Hyperglycemia are two main problems of diabetics, which can also be touchable for nondiabetics. Therefore, with the solution we suggest, we want to make these two problems not happen or happen less.

The Software-Intensive solution we suggest for diabetics has a set of features, which can make the three-goals of ours reachable. The software needs to be connected to database to store data of diabetic people.

The names of foods consumed by diabetic people and their amount need to be entered to software to find out how much sugar will get the diabetic person in a few hours. When the data has been entered, the amount of insulin needed to be injected will be shown to the diabetic person to avoid Hypoglycemia and Hyperglycemia. In some cases, diabetics consume less food and use more insulin, which can cause Hypoglycemia and vice versa.

On the other hand, we think about a feature, which connects the software to GPS services to calculate the covered distance by diabetic person. This is also be useful to reduce the amount of insulin needed to diabetic person. The software has all the data of the diabetic person including his/her weight, height, diabetes type, the amount of normal insulin needed for him/her and the maximum daily distance needs to be covered by him/her. In this case, the software notifies the diabetic not to do more running or jugging in just one day. Otherwise, he/she may face

hypoglycemia. Or when that condition happened to him/her, the software suggests him/her to eat a candy or to eat a bit more food.

As another feature of our solution, we mention avoiding hyperglycemia or hypoglycemia during nights and sleeps. Diabetics cannot control or check the level their blood sugar during nights and sleeps and this takes for about 8 hours. In this period, they may face hypo or hyperglycemia. However, there are useful methods to avoid this and we do not want to mention them. The software-based solution we suggest will be able to warn diabetic person and awake him/her in case of having more than normal amount of sleep. As an instance, it will notify the user (diabetic person) to wake up and check his/her blood sugar level with specified tools during his/her sleep. Furthermore, the software will be able to connect to smart glucose monitoring devices as IoT (internet of things) or IoE (internet of everything). It can store the sugar amount of diabetic people's blood in database and evaluate the times, which the person faces hypo and hyperglycemia. Therefore, in those times, the software can warn the diabetic and/or his/her family to check the diabetic's health condition. Additionally, the blood sugar amounts of the person can be also sent to his/her doctor to evaluate diabetic's diabetes status.

Other than that, it will connect diabetics to their family and friends. In this case, the family or the friends of diabetics can be informed in case of passing out or unconsciousness of diabetic person. It is worth mentioning that the long duration of unconsciousness makes the risks of diabetes higher [3]. Hence, being in touch with diabetic person may shorten this possible situation and reduce the possible problems.

Controlling diabetes and the amount of blood sugar is hard for diabetic people. This can be hard because of a couple of reasons. First, it can be problematic to check blood sugar level periodically in every condition. Secondly, the diabetic person may forget to bring his/her blood sugar tester tool with himself/herself to wherever he/she goes [10]. In this respect, the solution suggested by us facilitates the life of diabetic people and controlling diabetes.

First, as mentioned earlier, it gets the information related to the food consumed by the diabetics and calculates the amount of insulin needed for each person and prevents more insulin consumption. Secondly, it connects to wearable devices and use the data produced by them. As an instance, sleep data will be used to facilitate insulin consumption and to avoid probable problems. Additionally, blood pressure or blood oxygen levels can also be measured using wearable devices to keep track of staying healthy.

As suggestions, the software-intensive solution will help diabetic people to find the nearest endocrinologist. Moreover, by scanning foods using smartphone camera, the user will get the information related to that food and when it is not healthy to a diabetic person, he/she would be informed. Medical test is one of the other uses of this solution. From time to time, it is better for a diabetic person to have a medical test to investigate how well he/she controlled his/her blood glucose during past times [1]. After the test is being done, it is possible to scan its results or take a picture of them and automatically send them to the endocrinologist. It can be also useful as a sports coach. After a while of inactivity, it warns the user about inactivity. Moreover, based on body shape, food consumption amount and insulin needed to a specified person, it sets a sport goal for that person. By reaching that goal, the user will get a notification in order to stop the workload and sports.

8. Conclusion

To conclude it, diabetes is a very common disease and requires constant tracking. It can be life-threatening if not taken good care. Diabetes management and a greater focus on lifestyle factors, can lower the risk complications and lead to better health. This is what our application would

help the diabetic patients achieve – a healthier lifestyle and allow for early detection of life-threatening symptoms. As discussed, it would allow them to keep a track of their food intake, physical activity, blood glucose and suggest them a nearest endocrinologist.

Despite the fact that there are many privacy and security issues to consider [20], it is expected that technology will continue to evolve and develop. It is assumed that IoT will become much more relevant in the healthcare industry around the world in the future. We can expect these upcoming-generation IoT devices to provide intelligent medical services administrations as a feature of their contributions in the future, as IoT devices become more convincing in healthcare facilities. Advances in information technology and new IoT technologies have already opened a slew of possibilities for the advancement of smarter healthcare information systems, and they will simply continue doing so over the course of the following years.

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STUDENT JOURNEY CONFIGURATOR PROTOTYPE: AN APPLICATION OF USABILITY ENGINEERING CONCEPTS

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Abstract: *Usability Engineering aims to improve the user experience by utilizing different techniques and methods. It mainly focuses on assessing the user behaviour characteristics in order to address them during the development stages of products and services. The user requirements and needs are being defined with the help of tools such as Personas, User Stories and Use Case Diagram. This paper documents the steps we have performed in order to test usability of our prototype for the Student Journey Configurator. The iterative testing lasted three rounds during which testers interaction with the prototype was observed. An interview was conducted with the testers after this to determine their thoughts about the prototype. The final prototype was improved based on the feedbacks and unimplemented suggestions have been documented for future development.*

Keywords: usability engineering, persona, user stories, usability testing

1. Introduction

This study is devoted to the Student Journey Configurator platform in the framework of Managing the Digital Transformation – Digital Education Ecosystem (ManDEE). Additionally, it is aimed to support the students who are planning to start their studies in the EuroPIM (European Partnership for Project and Innovation Management) program, which is one of the largest university partnership consortiums in the sphere of project management. The partner universities are from Bilbao (University of the Basque Country, UPV, Spain), Leuven (KU Leuven, Belgium), Kaunas (KTU Kaunas, Lithuania) and Trondheim (NTNU, Norway).

The platform itself is meant to provide easy-to-use access platform through which the prospective students could configure their studies in different aspects such as which type of specialization they want, whether or not they want the double degree and in which area, whether or not the students have work experience and so on. As a result, the overview of list of courses by semesters is provided, as well as with the list of workshops (with respective time of provision) and recommended links for student career services available from EuroPIM partner universities.

The main aim of this project is to develop a prototype of Student Journey Configurator and provide the usability tests with derived group of users. The underlying point is an attempt to reflect on the main pinpoints of usability engineering while conducting and developing the prototype of the platform.

The structure of paper is as following: Section 2 provides an overview of Usability Engineering; Section 3 is devoted to explaining Personas and their main characteristics; Section 4 focuses on User Stories and Use Case Diagram; Section 5 provides an overview of Student Journey Configurator prototype; Section 6 represents the application of Usability Testing and its phases; Section 7 is providing the comparison of Before and After states of iterative prototyping; Section 8 is providing the summary and conclusion.

2. Usability Engineering Overview

Usability involves introducing techniques to produce an easily usable and good quality of user interface [1]. Usability involves different aspects of design and data. When combined with computer systems and networks, it forms a system which is usable [2, 3]. Usability must be considered before prototyping, according to one of the core principles we've learnt in human-computer interaction (HCI). Techniques (such as usability context analysis) are available to help with early attention and commitment [4]. Exerting changes to the interface can be costly in all aspects and difficult to execute when usability detection, or testing, is done at the end of the design cycle, which leads to usability recommendations. These are frequently overlooked by developers who believe that they don't have usability problems. The sooner critical design faults are identified, the more likely they are to be fixed. Because design normally focuses on the synthesis stages, and user interface components include metaphors, mental models, navigation, interaction, appearance, and usability, user interface design should be more correctly referred to as user interface development, akin to software development [5]. It is widely agreed that any software project should include the following five basic usability characteristics: learnability, so that the user can get started working with the system right away; memorability, which allows a casual user to return to the system after a period of non-use without having to relearn everything; efficiency, which allows a user who has learnt the system to achieve a high level of production; a low error rate, which means users make fewer and more readily correctable errors when using the system and no catastrophic errors; and satisfaction, which makes the system enjoyable to use. These characteristics include trade-offs, and some are more significant than others, albeit this ranking varies depending on the situation. Long-term efficiency, for example, may be crucial enough for engineers to be ready to compromise rapid learnability [6].

3. Personas

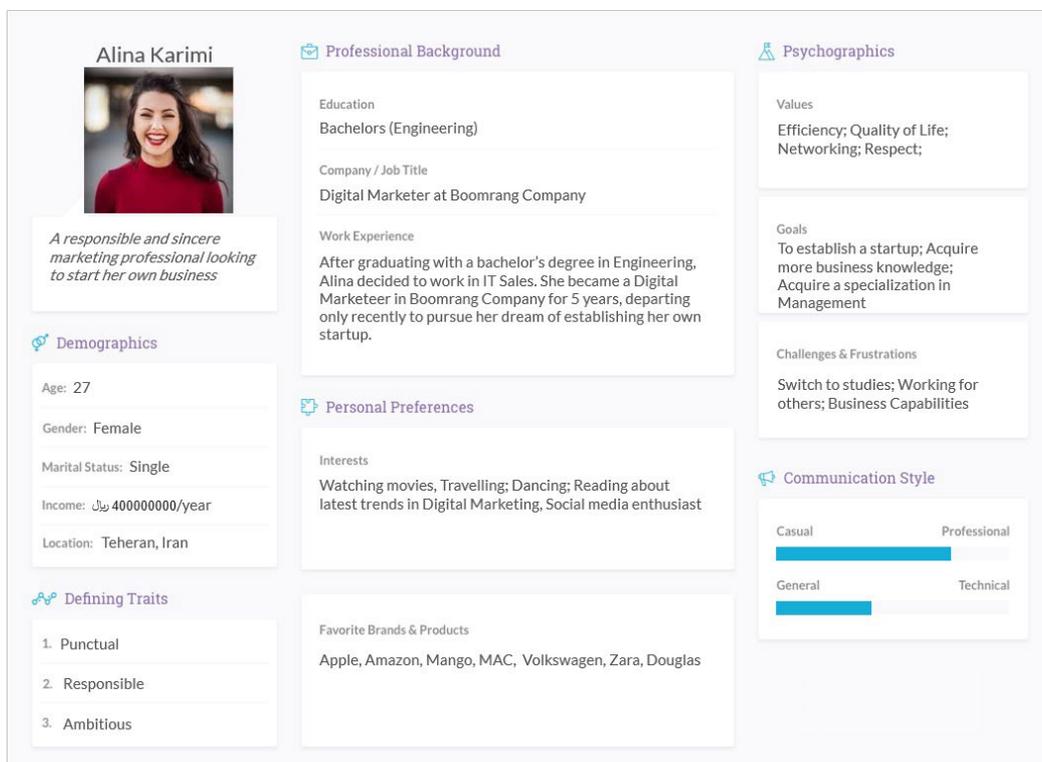


Fig. 1. Persona for Student Journey Configurator

Focusing on specific or canonical users is suggested by the persona’s method. The idea is to create a product that is tailored to a variety of people, generally a few dozen, who represent typical customers [7]. “Personas are fictional user archetypes based on user research. Through a process of analysis and refinement, the data from user interviews is distilled into one or multiple fictitious characters” [7].

To begin, the group has created two key personas (named Alina and Ayaan) to address their wants and requirements during the prototype's development. One of the identities is Alina Karimi, from Teheran, Iran. She chose to work in IT sales after finishing a bachelor's degree in engineering. She worked as a Digital Marketeer for Boomerang Company for 5 years before leaving to follow her goal of starting her own company. After researching on how to establish her own business, she concluded that she lacked skills in that area. In this regard, she applied for the EuroPIM program, which offers a dual degree specialty in project management and innovation and entrepreneurship. The information about this persona can be seen below (see Fig. 1).

4. User Stories

TABLE I. User Story Template

User Story ID	As a <type of user>	I want to <perform some task>	So that I can <achieve some goal>
1	<class> Student	Find Learning Path to a Specialization	Acquire a degree in that Specialization
2	<class> Student	Be reminded of upcoming deadlines for document submission	Complete submission of files (documents) on time
3	<class> Student	Find out about Double Degree Programs	Decide whether I want a double degree
4	<class> Student	Enroll in a double degree from a partner university	Acquire a Double Degree
5	<class> Student	Participate in exchange program	Attend a semester abroad
6	<class> Student	Get an overview of my Study Plan	Plan/Schedule my studies
7	<sub-class> Student Persona 1	Be specialized in Project Management	Become a certified PM
8	<sub-class> Student Persona 1	Further continue my studies in the sphere of PM	Pursue a PhD program in PM
9	<sub-class> Student Persona 2	Have better networking in business sphere	Utilize it for creating my startup (investments, partners, etc.)
10	<sub-class> Student Persona 2	Find programs, courses and workshops that are suitable for me	Ease the process of studying and increase and enhance my job skills

User stories are a technique of determining “high level requirements” from the perspective of the user [8]. We have used an “Agile User Story Template” to list our user stories (see Table 1). We have identified Student as a primary user for the Student Journey Configurator. User Story ID’s 1-6 represent the common use cases of both the personas (Ayaan and Alina). User Stories 7 and 8 are specific to persona 1 (Ayaan) whereas the user stories 9 and 10 are specific to persona 2 (Alina).

5. Prototype Design

As defined by Beaudouin-Lafon and Mackay “A prototype is a tangible artifact, not an abstract definition that requires interpretation” [9]. We decided to use Balsamiq’s wireframe [10] to design our prototype. For the Student Journey Configurator, we created 10 wireframe screens consisting

of browser windows. Some of the wireframe screens will be described in this section along with the navigation.

The figure below (see Fig. 2) shows the design of the first wireframe, the welcome page. This is the first page users will see once they login. There are options for language change, help and account settings on the top right corner. The button “Start Student Journey Configurator” launches the tool.

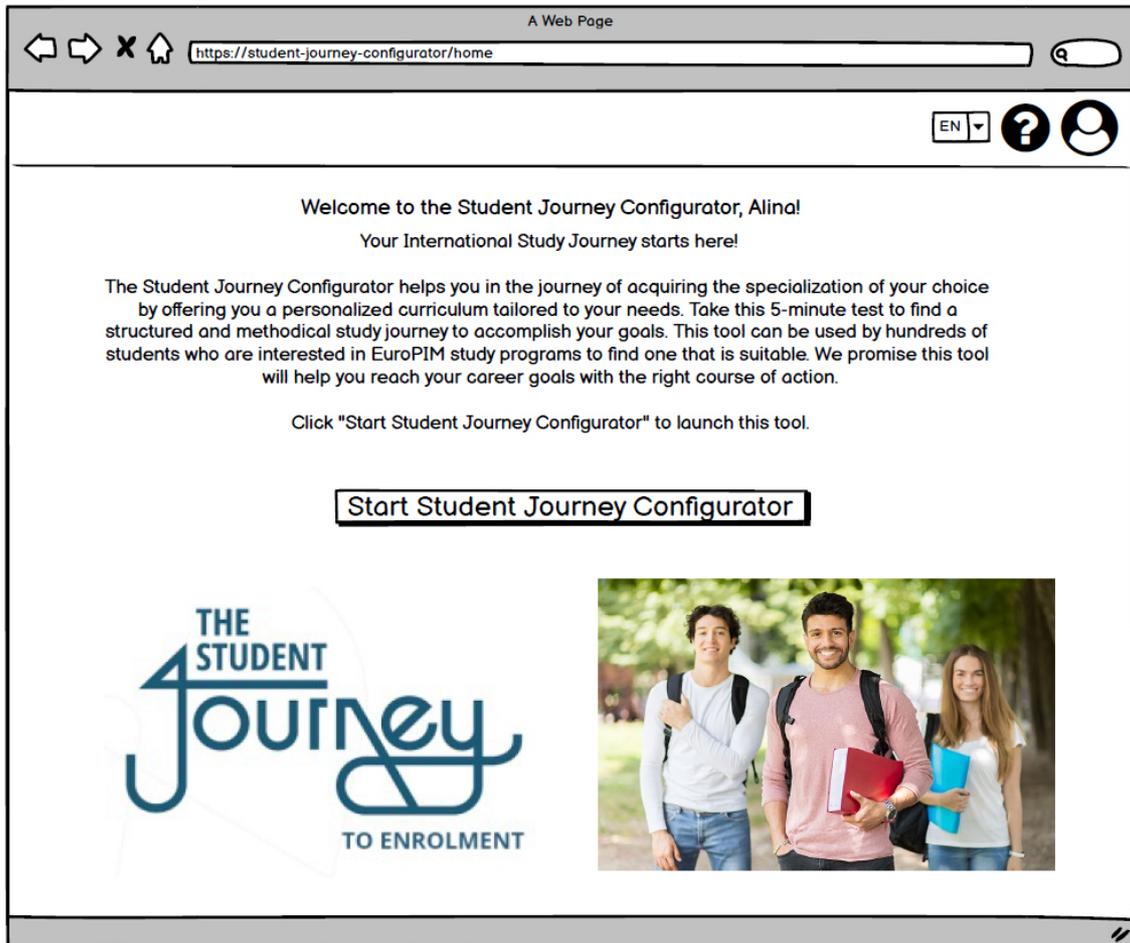


Fig. 2. Welcome Page

Once users click on this button, they will be redirected to the specialization page. Users can select a “specialization” of their choice from the options available in this page. These are “Project Management”, “Innovation and Entrepreneurship”, “Digital Transformation” and “Sustainability”. Once a choice is finalized, users can navigate to the next page.

The next page is the double degree page (see Fig. 3) which allows the users an option to choose a double degree from a partner university. A short description is given on the top of the page about double degree programs. If users select answer “Yes” in the first question, they can choose their specialization for the second degree from the second question in this page. Once all answers are selected, users can click on the button “Save & Next” to move to the next page. There is also a “Previous” button to navigate them to the previous page.

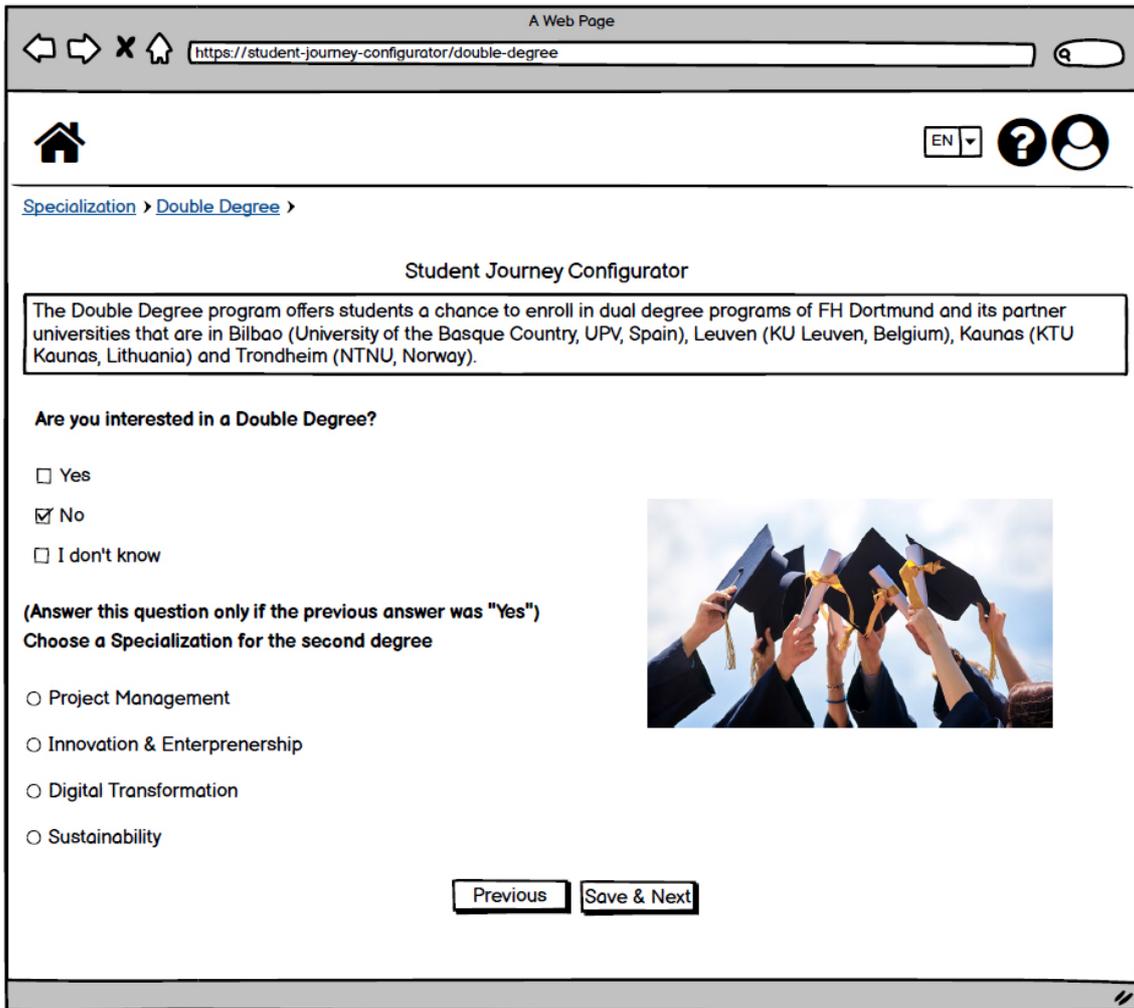


Fig. 3. Double Degree Page

The next page is the electives page which gives the users an option to select electives of their choice from a list of options. Users can also find more information about the elective subjects from useful hyperlinks in this page.

The next page is the Exchange Program page. If users are interested to study a semester abroad, they can select the option “Yes”. If they require more information about this program, they can find so from useful hyperlink in this page.

The next page is about work experience. Users can select how much experience they have from this page. They can also add more details about their work experience in this page.

The next page is about “Extracurricular Activities”. It describes a list of different courses that are conducted during the semester break via the career service. These modules are not compulsory for the students; however, they can enroll in them to enhance their skills. Users can contact administrators for arrangement of new courses from this page.

Once users’ save their choices, they will be redirected to the “Preview” page (see Fig. 4).

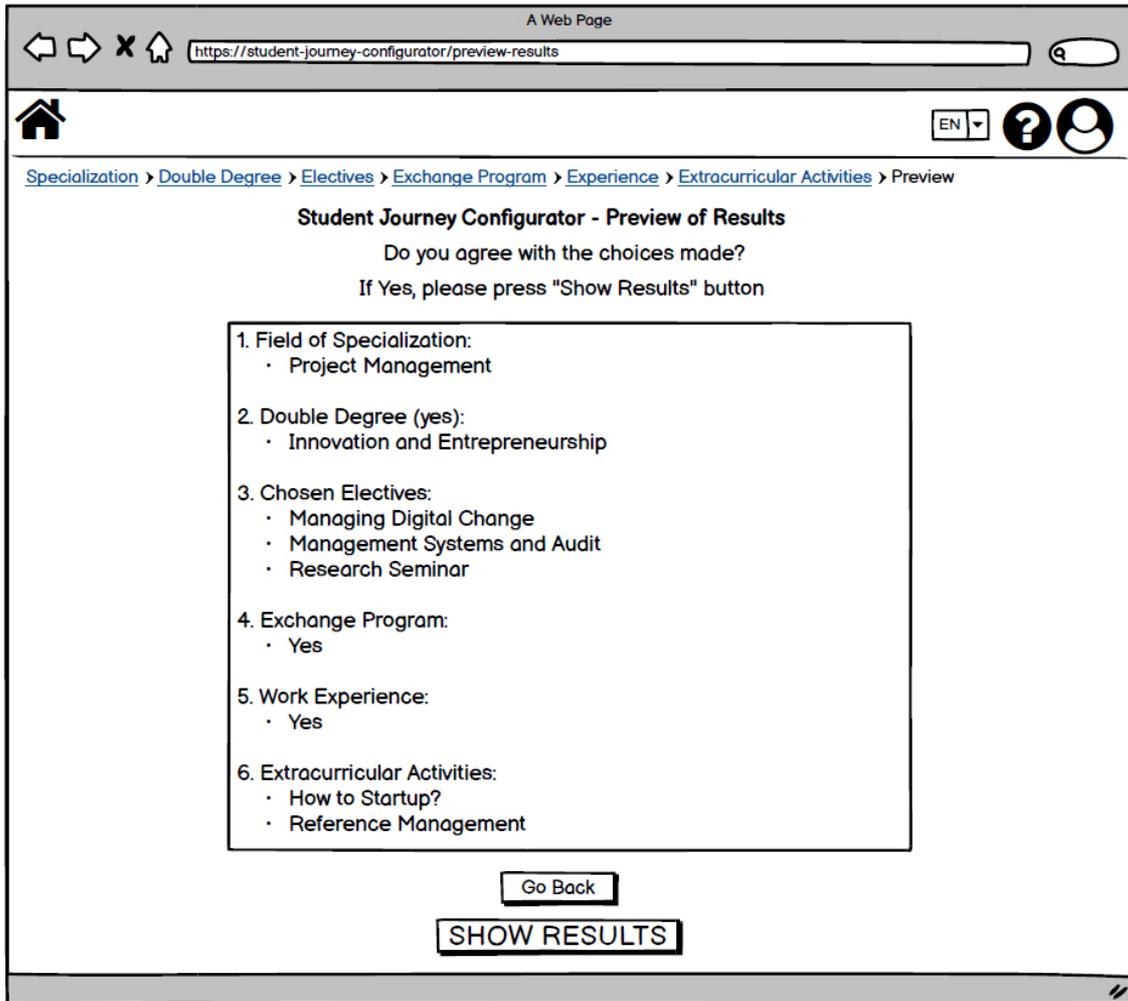


Fig. 4. Preview Page

This page displays all the answers which the users have selected for each question. If they want to change any answer, they can click on the “Go Back” button to navigate to the previous pages and update their answers. Once they are happy with all the answers, they can click on the “SHOW RESULTS” button to see the outcome of the Student Journey Configurator tool. This is displayed in a separate webpage (see Fig. 5). The first table displays semester wise modules that has been prepared based on users’ choices. The second box shows extracurricular courses that the users have been enrolled to. The last box displays a recommendation message from the tool as well as hyperlinks to some helpful webpages. These include the various career portals, job opportunities and internship pages from the partner universities of EuroPIM.

The screenshot displays the output of the Student Journey Configurator for the course EUROMPM (IT). The interface includes a browser window with the URL <https://student-journey-configurator/results>. The main content is a table with four columns representing Semesters 1 through 4. Semester 3 is noted as an exchange semester at UPV Spain. Below the table, there are sections for workshops during the semester break and a recommendation section with several links to external resources.

Semester 1	Semester 2	Semester 3 (Exchange Semester at UPV Spain)	Semester 4
Project Management Fundamentals	International Comm & Change Management		
Project Planning & Controlling	Multi Project Management & Organization Leadership & Teams	Research Seminar	
Self Management & Social Competence	Digital Business & Ecosystems	Management Systems & Audit	Master Thesis
Quality Management & Standards	Managing Digital Change (Elective)	Project Thesis	
Transversal Skills			

WORKSHOPS DURING SEMESTER BREAK

"How to Startup ?" - 30th August 2021, 9:00 - 14:00 hrs
 "Reference Management" - 3rd September 2021 - 5th September, 10:00 - 12:00 hrs

An email for enrollment confirmation has been sent to your account . Cancellation is possible from ODS, at the latest 1 Week before the course starts.

RECOMMENDATION

It is recommended to be familiarized with the workshop offerings, internships, and part-time jobs available through the DEE platforms.

[Job Market at FH Dortmund](#) [Student Career Services at KU Leuven](#)
[Career Service at FH Dortmund](#) [Career portals at NTNU](#)
[Internship places at KTU](#) [Job centres at UPV/EHU](#)

[More Information about Modules](#) **RETURN HOME**

Fig. 5. Student Journey Configurator Output

6. Testing

Usability testing is a key skill for usability practitioners whose main objective is to advise software developers to make their products more user-friendly [11]. Usability testing is one way to ensure that interactive applications are tailored to the users' needs and roles, with no negative consequences. The usability evaluation is a critical step towards an interactive system and its design process, whether it be a program, Web, IT, or service. The usability assessment aims to evaluate the efficiency and reliability of the system. (i.e., how well the system performs and how much time and effort needed to use the system functionalities) [12].

After creating the first version of the prototype, we performed usability tests on our developed prototype. The tests were performed by derived tester groups. The testing process was carried out on the conference platform of Zoom©. The link to the Balsamiq Cloud prototype was sent to the testers directly to avoid direct interaction from the developers. A quick overview of Wireframe was given to the tester during the conference call. The team had offered the following guidelines to reduce the potential for bias during the test: testers may think aloud, interact with the prototype, and inform team when they are through. In addition, we requested testers to share their screen. We recorded the first 3 tests with testers' consent. The aim was to observe their reactions, interactions with the prototype, areas of confusion and difficulties, areas that delight them most and document them. Finally, we collected feedback and suggestions from the testers.

We conducted testing in three phases, with 15 different users from various backgrounds and regions. In Phase 1, we tested with 3 users. After receiving their feedback and suggestions, we

made some minor changes to our prototype. In Phase 2, we tested our prototype with 9 different users and made significant changes based on their feedback. Finally, we tested our modified prototype with 3 users, and it proved to be more user-centric and easy to use.

6.1 Summary of Test Results

The overall issues the testers faced in each webpage are summarized in this section. These are as follows:

Most testers pointed out that "Save" button was confusing, and the main point was not understandable in the first prototype. In addition, some testers suggested replacing the button with "Back and Next" buttons so that easy navigation could be found across all web pages.

The "Course Overview" button featured in the first prototype caused test-takers to become distracted. Furthermore, the main goal of it was not clear to them because it was meant to provide some additional information as a reference for the list of subjects and courses available in the program. As a result, it was decided to include that information on a webpage about course selection as a hyperlink to the program modules handbook. In the final version of the prototype, the webpage with the course list was removed from the first "Home" page.

Some testers did not understand the questions about exchange semester. An additional hyperlink that redirects to the information page was introduced to increase clarity. A text box was also added to convey information about the program.

Some testers couldn't understand what the "Double Degree Program" meant. In this case, additional program information was added in the webpage. Apart from that, there was a problem with the options, which were displayed as buttons rather than checkboxes. Later, checkboxes were used to represent options in order to be consistent and coherent in terms of design.

One of the main issues during Testing Phase 1 was that some users were unable to reach the "Results" webpage due to the initial navigation structure, which caused confusion. As a result, the breadcrumbs hierarchy of webpages was introduced so that testers would not be confused by the Student Journey Configurator's step-by-step procedure. Apart from that, testers were unsure whether they had completed the procedure or not, which was a platform usability issue. In this regard, a webpage with a preview of the results was introduced with the option to edit the choices made. The resulting overview of the study program was presented in such a way as to indicate that it is the Student Journey Configurator's final page.

6.2 Recommended Changes

After Test Phase 1, we implemented minor changes in the prototype based on testers' feedback. These include the following:

- We moved "Course overview" button on the top right corner (instead of top left corner)
- We moved "Start Student Journey Configurator" button from bottom of the screen to the middle of the screen
- We renamed button "Save" as "FINISH" in "Extracurricular Activities"

After Test Phase 2, we implemented major changes in the prototype, which are described as follows:

- Deleted “Course Overview” and “Elective” screens as well as nested screens
- Updated message in the “Home” screen to reflect Persuasive Design
- Added hyperlinks wherever necessary to redirect to information webpages.
- Renamed “Save” button to “Save & Next”, added new button “Previous”, renamed “Next” button in Configurator Output screen to “RETURN HOME”
- Made UI more user-friendly: added instructions where necessary, added additional questions, modified existing choices, etc.
- Added “Preview” screen with button for showing results
- Updated Table in Configurator Results, merged content of two output screens to one
- Rephrased questions in the some of the screens for clarity

After Test Phase 3, we documented the changes suggested by the testers, however these are not implemented yet. These include the following:

- Introduce Chatbot functionality to be able to ask questions
- Introduce a way to save the final results as pdf/excel/any other form of document

7. Comparison of Before and After: Iterative Prototyping

The elaboration of the versions of implemented prototype before and after are introduced according to the changes and alterations made based on testing feedbacks.

In particular, in first version of the “Home” page, during the Phase 1 of Testing, there was some confusion with the “Course Overview” button that created attention diversion. The purpose of it was not understandable by the testers. Another point is that the text conveying the main purpose of the Student Journey Configurator was not easily understandable by the testers. Lastly, the “Start” button was not in an intuitive place, due to which some testers couldn’t start configuring the studies for some time.

In the final version, from the top bar of the webpage, the icons of “Home” and “Help” buttons have been changed, thus it will be more intuitive for the testers. Moreover, Fogg [13] put forward the claim that behavioral characteristics and patterns of users can be pre-dispositioned to the external persuasive factors that are responsive to particular aspects of behavior. In that regard, the introductory text of the Student Journey Configurator has been updated and modified in such a way to reflect the concept of Persuasive Design, thereby enabling differentiated aspects of user behavior. Finally, the “Start” button was placed in the middle of webpage with increased font size so the testers could easily start the configurator.

8. Conclusion

In summary, this research work has provided the characteristics and differentiated traits for the main types of users and their behavioral patterns using different tools and techniques such as Personas, User Stories and Use Case Diagram. Based on these derived definitions and concepts, a prototype of the Student Journey Configurator was developed. Further, in order to provide the iterative and continuous development of it, the research team has provided the usability tests with derived group of users (focus group). By conveying the concepts of Usability Engineering, there were provided in total 15 testing cases with diversified focus group comprising the 3 distinct phases: Phase 1 was contemplating 3 test cases and minor changes and updates have been made; Phase 2 consisted of 9 test cases and major changes were introduced into the prototype development; last Phase 3 was devoted to confirming and validating the usability features of final version of the prototype with 3 test cases. All the user feedbacks and suggestions were

documented in the form of protocols and notes. The iterative prototyping approach for changes and improvements is taken as a backbone of the development.

In conclusion, we attempted to reflect the main pinpoints and underlying concepts of Usability Engineering while conducting and developing the prototype of the Student Journey Configurator platform.

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FHYDRATE – PROTOTYPING FOR SUSTAINABLE TREE WATERING IN PUBLIC AREA

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Abstract: *In view of climate change, efficient tree watering in public area gains in importance. The project FHydrate uses IoT application LoRaWAN as prototype in the city of Dortmund. It is a research in progress sustainable and scalable project for public private partnership. This paper tends to reply the next research questions (RQ). RQ 1: How can soil moisture sensors be used for sustainable tree irrigation in the public sector? RQ2: What is a city or county expecting from the prototype? RQ 3: Which information must be transferred to people with intrinsic motivation?*

Keywords: climate change adaption, water management, IoT, smart city, sustainability, LoRaWAN, sensors, project management, research in progress, public private partnership

1. Introduction

The frequency and intensity of extreme weather events will continue to increase in the future. Scientists assume that the increase in extreme weather events can be attributed to global warming. [1] The risk of heat waves, droughts, storms and floods is growing, especially in urban agglomerations. [2] As cities emit a lot of greenhouse gases, they are also causing climate change. [3] The urban heat island effect and the dynamics of extreme weather events are intensified by the dense settlement and sealing of areas. [4]

In addition to the overall avoidance of greenhouse gases, trees have a particular significance for active climate protection and adaptation to climate change. By filtering greenhouse gas CO₂ they have a preventive effect. At the same time, they provide protection against soil erosion and ensure cooling in the urban climate through shading and transpiration. For this reason, the creation of urban forests and parks in cities such as Paris is already one of the essential measures in sustainable climate protection. [5] Trees are investments for cities that pay off through planting and care, especially in the first years of life. Systematic irrigation is decisive here ensuring (to ensure) that these investments are sustainable and that the trees remain vital. In public perception, the condition of trees is equally important for a livable city as trees are severely affected by periods of heat and drought. [6]

For this reason, it is necessary to protect tree populations in cities through proper irrigation. On the other hand, information is required on how trees can most efficiently achieve their benefits to the ecosystem. Data bases on soil characteristics, irrigation, soil amendments also in correlation with tree species and locations can be decisive for climate-appropriate urban development. On the one hand, generating data in that way demands technologies for sensor technology and data transmission. On the other hand, involving different stakeholders is crucial, as well as incorporating botany, urban planning, landscape management and marketing in an interdisciplinary approach.

The research project FHydrate, launched in April 2021 by the faculty of computer sciences at Dortmund University of Applied Sciences and Arts in cooperation with the city of Dortmund and external expertise, takes a holistic approach to this topic. As a sustainable project in cooperation

with common administration, it is intended to provide transferable knowledge on the following (research) questions:

- What data is relevant?
- How is the data being measured?
- What are the transmission paths?
- How can the data be used systematically by the participants?

The FHydrate project will be continued and further developed as research in progress with students in the upcoming winter semester. Focusing on the first two research questions, the following investigation will address the selection of data to be measured and the sensors for data collection. Transmission paths and data use have already been iteratively included into the project design to be explored in more detail in further research. The technological basis is LoRaWAN (Long Range Wide Area Network), which has been developed for IoT applications.

2. Research Method

In this chapter, the procedure for the installation and implementation of the soil moisture sensors is shown. The concept was developed in close cooperation with the city administration of Dortmund, following the Design Science Research (DSR) approach. The structured approach underlying the DSR allows the practice-oriented work to have a scientific basis.

Fig. 1 shows how Hevner and Chatterjee describe the principle of this approach. The diagram is divided into three areas. The first area Environment is shown as the application field of the research. The knowledge base serves as the scientific foundation and is essentially the source of the available information. The middle and decisive area DSR represents the connection of the areas and is the core of this project. The project is conceptualized with this in mind. To meet the requirements of the project, previous experiences have to be considered and expert knowledge has to be analyzed. This allows new processes and architectures to be designed.

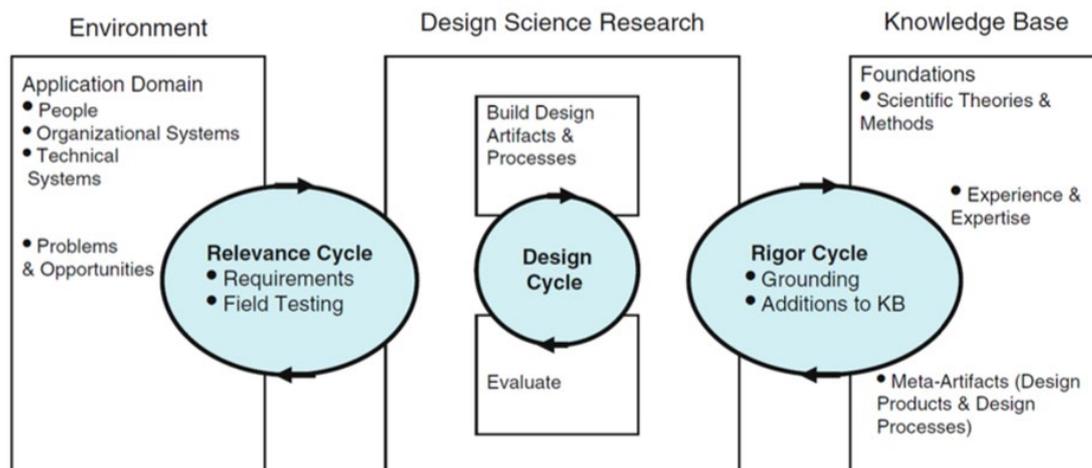


Fig. 1. Design science research method [8]

If the principle of the DSR approach is adapted to the procedure of this work, a connection between the individual areas and the overarching cycles can be seen. The Rigor Cycle is clarified as a link between the already existing knowledge base and the DSR in the chapter “holistic approach”. This section serves to present the existing scientific findings and to incorporate them into the work. For this part, especially technical literature was used. The Relevance Cycle

represents the interface between the environment or the application field and the DSR. This cycle is presented in the chapters “technical implementation”. In addition to illuminating the current architecture and existing processes, the design requirements are described there. The Design Cycle thus incorporates all existing information and findings as well as the requirements.

3. Holistic Approach

The FHydrate project aims to protect urban tree cover through proper irrigation and to maximize the positive effects of trees on the ecosystem. In doing so, the focus is on technical and organizational implementation in cities. By prototyping for sustainable tree watering in public area, an optimized and transferable process model shall be developed. The following requirements are already defined and will be considered in the further research:

- Biological requirements for the data set ("collect specific data")
- Technical requirements for data acquisition and data forwarding ("making data collectible and usable")
- Organizational requirements for the actual use of data ("activate stakeholders and secure implementation")
- Legal requirements for dealing with data ("include data protection")

As a prototyping project, FHydrate uses trees at the sites of Dortmund University of Applied Sciences and Arts and in the city of Dortmund. Students, practitioners and professors from different scientific fields are actively involved into the project: Business data processing specialists, IT engineers, green space managers, project managers, designers.

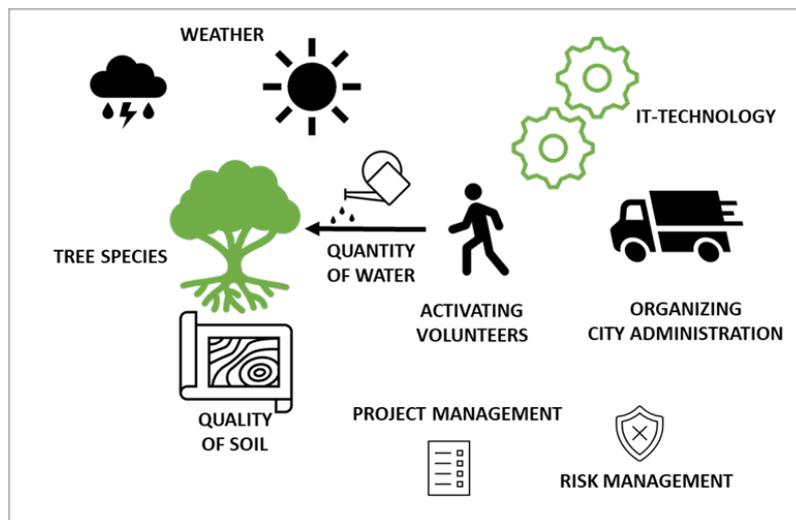


Fig. 2. Holistic approach

The following exploration focus on the technical implementation based on LoRAWAN. The selection of sensor and the visualisation of data considers primarily the immediate requirements of trees: the quality of soil and the need of water. With regard to the early status of the FHydrate project, the additional topics will be examined more closely in the following studies.

4. Organizational Framework

As a prototyping project FHydrate has to define the concept of the application system to be developed. This requires two basic steps: Firstly, an as-is analysis must be carried out, which examines the current conditions and creates the prerequisites for the concept. Secondly, the

concept itself must be created, which primarily contains the technical requirements for the application system. These are coordinated in order to create a holistic concept for an implementation approach after the requirements elicitation has been completed.

The goal is to measure the vitality of selected trees and ensure it in the long term. For this purpose, sensors will be installed on two trees as a prototype, which will regularly generate measured values, e.g. on soil moisture. These will be made available to interested parties on a web platform so that watering needs become immediately visible.

As-is analysis is a very important phase of project management. Within the scope of the as-is analysis, the initial situation (actual state) of problems should be determined objectively. The recording of the actual state can be executed by means of different survey techniques. For the most comprehensive recording of the actual state, a distinction is made between primary and secondary survey. In the primary survey, the collection of all information is obtained for the first time and specifically for the purpose of the survey. The secondary survey is based on existing documentation and sources, i.e. essentially the existing documents are evaluated. Primary survey methods can be divided into the interview method (oral questioning), the questionnaire method (written questioning), the report method and the observation method. As a secondary survey, only the inventory method should be considered.

As the corresponding documentation of all the information required is not available in this project, its focus is on the interview or questionnaire method. Question catalogs have been designed and worked through entirely with the help of different stakeholders. In addition to that, the existing documentation which is relevant to the project can be used as well.

5. Technical Implementation

The following text is about the technical implementation of the FHydrate project. It is separated in two sections. The first section is about soil moisture sensor near to the trees. The second section deals with the visualization of the data. Fig. 3 depicts an overview of the communication channels and the different actors involved in the technical implementation.

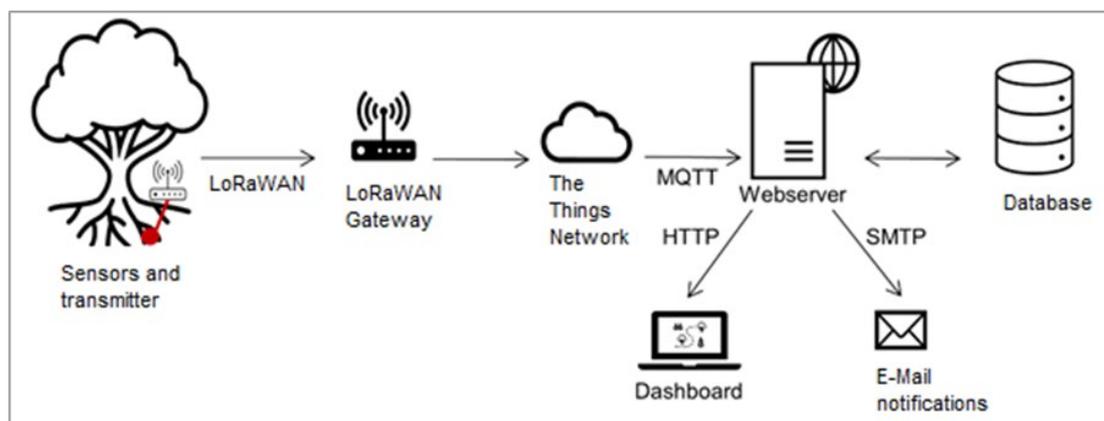


Fig. 3. Communication channels and actors

5.1 Soil Moisture Sensor

The Soil moisture sensor installation has been realized in cooperation with the city administration of Dortmund. They dugged holes for the sensors. In order to evaluate the measurement quality, we decided to install sensors next to two trees. One of them is a Maple-leaved plane tree at Sonnenstraße 100 in Dortmund. The other one is a Norway maple tree at Emil-Figge-Straße 38-

42 in Dortmund. Three sensors have been installed next to each tree in the ground (Fig. 4). Each hole is at a different depth: 30cm, 60 cm and 90cm. According to the TASPO BAUMZEITUNG 03/2018 p. 36, this is the optimal solution to measure the soil moisture. We used the sensor type “Soil Moisture & Temperature & EC Sensor MODBUS-RTU RS485”. We decided to use those sensors because, they are the cheapest sensors that can be placed in the ground and do not need to be shipped from China. That is why the risk of delay in delivery is reduced.

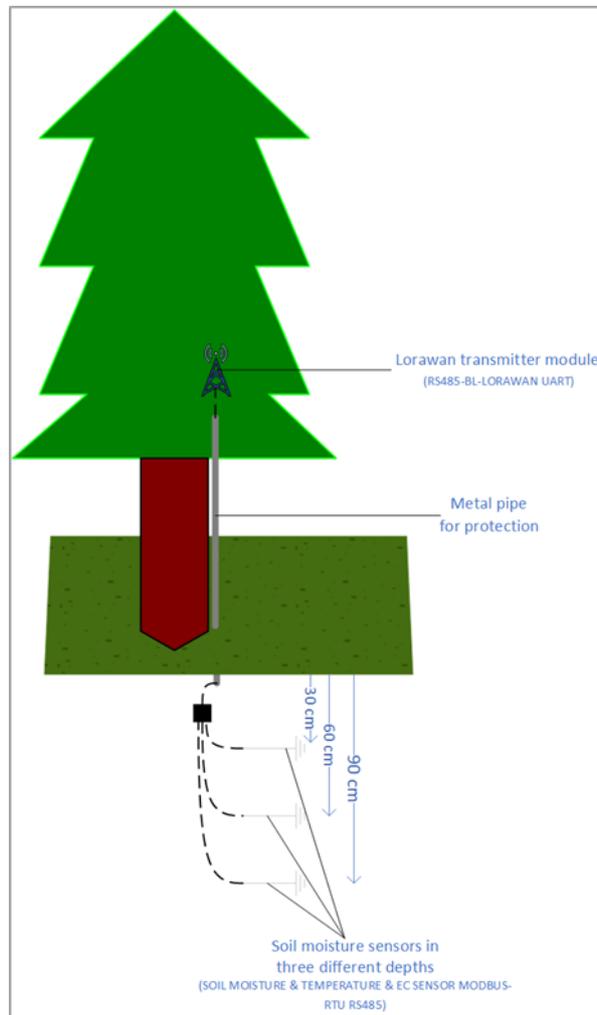


Fig. 4. Installation of LoRaWAN sensors and protection

The transmitter modules were installed in the treetop to get the best transmission results possible. It transmits the data of the sensors to a Gateway. The transmitter module is a RS485-BL - LORaWAN RS485/UART CONVERTER. Since it has been produced by the same manufacturer, it was the best solution. Moreover, the big battery pack inside the sensors as well as the easily understandable documentation in English are significant advantages. For the communication between the sensors and the transmitter module two protocols have been tested, RS485 and UART. After an evaluation we decided to use the RS485 protocol. With this protocol we need only one cable is required instead of three to connect the sensor to the transmitter. It also gives us the possibility to connect more sensors to the transmitter because we need less connections to connect the soil moisture sensors. The cable was placed in a metal pipe attached to the tree. The metal pipe shall protect the cable from vandalism and animals.

To transmit the data wirelessly from the transmitter to the server, there are different protocols available. We had the following options: Weightless, SigFox, Wifi LowPower, Dash7, LTE-CAT 0 or UMTS. [7] After an evaluation we have chosen LoRaWAN because it is cheap, has a long range, saves energy and because a gateway is already installed in the University of Applied Since Dortmund. The gateway is already a part of The Thing Network. Also, we use the Things Network to transmit the data from the gateway to the server. For this transmission we use the MQTT Protocol.

5.2 Visualisation

To visualize the data, we developed a website which is hosted on a virtual machine from the IT-Support of the University of Applied Since Dortmund. Before we started developing this website, we checked available software for displaying data in the required way. But a suitable software was not available on the software market.

The solution for our website consists of three parts: frontend, backend and database. The frontend and the backend are hosted in a node js Server. The database is a postgres database. We have chosen this combination because we are already experienced in this software. To secure the communication about the internet we additionally installed a reverse proxy which enforces communication about https. The Backend has three tasks: Pulling the tree data from “The Things Network” and putting it in the database, sending mails with tree information and responding requests from the frontend. This way the website (URL: www.fhydrate.fh-dortmund.de) activates the volunteers who are responsible for the trees.

When a specific value is passed, the responsible volunteer for the tree receives information by text message that the tree must be watered. The period of action for the volunteer to irrigate the tree is three days. The predefined level is reached through proper irrigation.

Fig. 5 shows the Frontend of a landing page with information about FHydrate and a map with the trees and the sensor data.

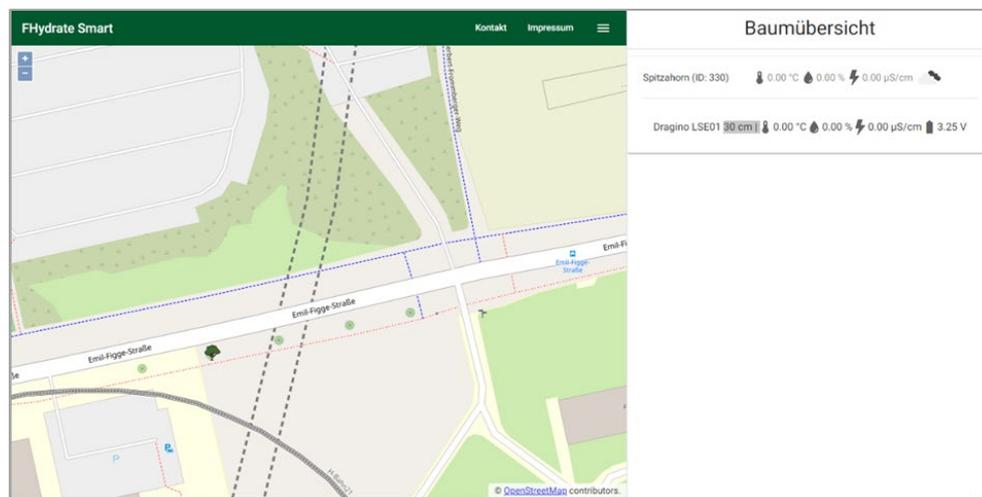


Fig. 5. Installation of LoRAWAN sensors and protection

6. Summary, Conclusion and Outlook

FHydrate aims at efficient hydrating and controlling the water requirement in public area. This research project has been launched with the City of Dortmund to get information about the soil quality of selected trees. There have been two trees selected as prototypes.

These two trees have been prepared with three sensors at each tree in a depth of 30, 60 and 90 cm. A steel pipe of 3 meters is going from the sensors to the crown of the tree to protect the cables from vandalism. The sending part at the end of the steel pipe is transferring data via LoRaWAN to the server.

FHydrate offers the possibility to act specific and to save a lot of water, action and money if enough volunteers are taking responsibility for trees in the city and will irrigate the trees if necessary. On the other hand, this project proves that it is possible to measure the quality of the soil of trees and to integrate the inhabitants of Dortmund in a sustainable project.

The next step will be to equip more trees with the sensors to get more information on the soil quality in Dortmund. In the future, a new research project must find new ways to measure the soil quality without putting sensors in the foreground. The focus will lay on the following questions: Is it possible to get the same information by using weather data, carbon dioxide sensors, temperature sensors and further sensors? Finally, it is necessary to activate several volunteers who will take responsibility for a tree and to organize the logistics of watering by the city administration. The items of public relations and logistics get relevance.

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DEVELOPMENT OF A TIME-OF-FLIGHT 3D AND POLARIZATION CAMERA FOR AUTOMOTIVE APPLICATIONS

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Abstract: *This paper presents the panoptes project which aims the development of a fast, robust, and power efficient fully integrated 3D and polarization camera based on the Time-of-Flight (ToF) principle for automotive applications. The project focuses on the field of integrated circuit design and mixed signal design and considers the impact of parasitic effects of chip layout. The objectives concern three main areas which are the increase of the distance measurement accuracy to value a smaller than one cm, polarization measurements with a diattenuation ratio of more than 90 by use of integrated polarization filters, and the increase of the measurement range to over 100m by using SPAD technology.*

Keywords: Time-of-Flight (TOF), autonomous driving, microelectronics, integrated circuit design, time-to-digital converter, polarimetry, mixed-signal design

1. Introduction

While ToF 3D imaging is an established measurement methods in many applications, measuring long distances larger than 100 meters with high accuracy less than one centimeter is still a challenge. In order to provide depth information, the propagation time of a light pulse originating from a light source, being reflected by an object in the scene and then reaching the sensor is measured for each pixel. In this research project, innovative circuit concepts and active control are used to improve the temperature-stable synchronization between the light source and the sensor, which is a key factor to improve the measurement accuracy and precision. For long distance measurements the sensitivity of the photo detector is crucial. Therefore, highly sensitive Single Photon Avalanche Diodes (SPAD) cells will be integrated and tested under automotive conditions to measure distances up to 100 meters. Since SPAD cells are electrically different from conventional photodiodes, an adapted readout architecture based on Time to Digital Converters (TDC) is required. A major focus of the project is the implementation and characterization of integrated polarization filters under consideration of the properties of the existing metallization layers in the used sub- μm CMOS process.

Integrated polarization imaging has the potential to provide additional information about the material properties of detected objects and to simplify the computationally intensive analysis of the recorded distance images and help prevent accidents by correctly interpreting the detected objects in a traffic situation.

2. Time-of-Flight Measurement Methods

Depth information in a 3D camera is extracted by means of a time measurement in each pixel. The propagation time of a light pulse is measured which is transmitted by a light source, reflected

by an object at a distance L and detected by a sensor with a two-dimensional structure of light-sensitive pixel elements in the immediate vicinity of the light source.

As shown in (Fig.1) the light beam has traveled the path $D=2L$ during the transit time T_d , so the distance L of the object from the sensor can be calculated using the speed of light by the equation $L = \frac{1}{2} c_0 T_d$. The goal of the measurement is therefore finding the time delay T_d [1].

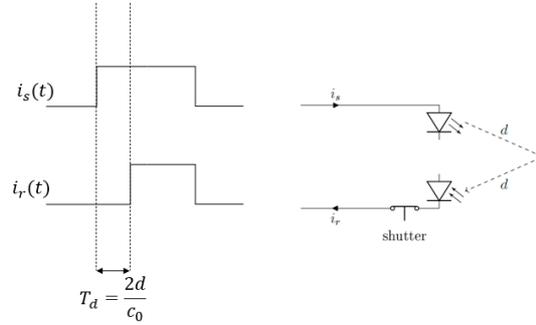


Fig. 1. Time of flight measurement principle

The relationship between depth and time resolution evaluates to $\frac{\partial T_d}{\partial d} \approx 67 \frac{ps}{cm}$ using the speed of light in a vacuum. In order to achieve a depth resolution in the centimeter range, T_d needs to be measured with an accuracy below 100 ps for each pixel independently. Instead of measuring the time interval T_d in this order of magnitude directly, it is possible to use an indirect approach based on the accumulated photogenerated charge in the sensor.

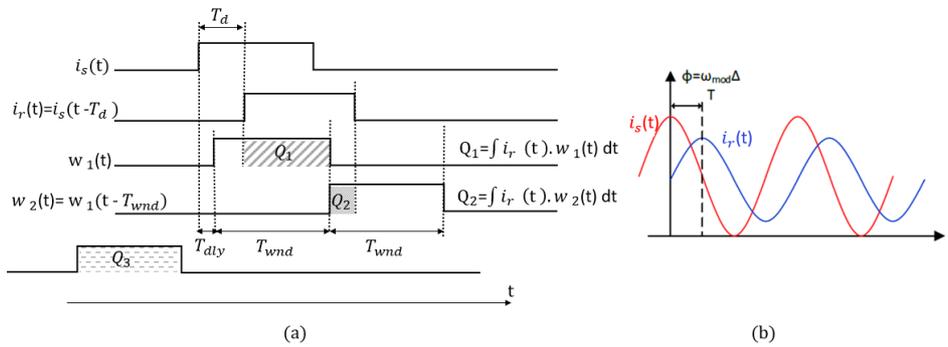


Fig. 2. (a) Windowing of received light for indirect time measurement, (b) Continuous ToF measurement

The reflected light pulse falls on the sensor and generates the electrical charges Q_1 and Q_2 accumulated during the two time-windows, $w_1(t)$ and $w_2(t)$, by means of a shutter. As shown in Fig.2. the integration corresponds to an accumulation of charge in the pixel behind the shutter and the relationship between Q_1 and Q_2 is determined by the arrival time of the light pulse relative to the beginning of the first window.

$$T_d - T_{dly} = T_{wnd} \cdot \frac{Q_1}{Q_1 + Q_2} \quad (1)$$

The shutter is implemented as an electronic switch and the two charges Q_1 and Q_2 are collected in subsequent measurements by shifting the shutter pulse relative to the laser pulse, assuming that the scene is stationary in the meantime. To reduce the distortion of the charge values due to the influence of background light, a third measurement with the same duration is performed without

active illumination. With the assumption that the intensity of the background light varies only slowly, the charge Q_3 read out during the third measurement can be subtracted from the charge Q_1 and Q_2 . To prevent background light from affecting the dynamic range by saturating on of the pixel, optical bandpass filters are usually used which limit the sensitivity of the receiver to the wavelength of the emitted light.

$$T_d - T_{dly} = T_{wnd} \cdot \frac{Q_1 - Q_3}{Q_1 + Q_2 - 2Q_3} \quad (2)$$

In additional source of inaccuracy is the delay T_{dly} between the light-source switch-on time and the shutter activation which will be discussed in the next section.

An alternative ToF measurement approach uses continuous light which is modulated in intensity by a special long-wave pattern. As shown in Fig .1(b), the propagation delay is determined by the phase shift φ of the reflected signal $i_r(t)$ with respect to the originally emitted signal $i_s(t)$, which serves as a control signal for the source and as a reference signal for the receiver [3]. For sinusoidal signals with modulation angular frequency ω_{mod} the emitted signal is given by, $i_s(t) = \cos(\omega_{mod}t)$ and the reflected signals equates to $i_r(t) = b + a \cos(\omega_{mod}t - \varphi)$, where the term b describes the background light and the coefficient a corresponds to the amplitude of the signal $i_s(t)$ and received signal $i_r(t)$. In the receiver the cross-correlation between the reference and the received signal is calculated, which results in

$$c(\tau) = \lim_{T \rightarrow \infty} \frac{1}{T} \int_{-\frac{T}{2}}^{\frac{T}{2}} i_r(t) \cdot i_s(t + \tau) = \frac{a}{2} \cos(\varphi + \psi). \quad (3)$$

Where $\psi = \omega_{mod}\tau$ corresponds to the adjustable internal phase shift of the reference signal $i_s(t)$. The cross-correlation $c(\tau)$ is taken in a sequence of four frames with different phase shifts of the reference signal of $\psi = \{0^\circ, 90^\circ, 180^\circ, 270^\circ\}$. The phase shift φ of the reflected signal associated with the distance measurement can then be calculated by the equation.

$$\varphi = \arctan\left(\frac{c_{270} - c_{90}}{c_0 - c_{180}}\right) \quad (4)$$

From the phase shift φ of the reflected signal, the distance to the measurement object results in

$$L = \frac{c_0}{2\omega_{mod}} \cdot \varphi \quad (5)$$

Due to the periodicity of the modulation pattern, a clear distance measurement is only possible up to a phase shift of 2π or a distance corresponding to half of the modulation wavelength.

3. Temperature Compensation of the Light-Source Switch-on Delay

The temperature-induced loss of synchronization between the light source and the sensor matrix leads to a reduction in measurement accuracy that can currently only be compensated by a complex calibration procedure. By integrating a TDC into the ToF camera and by optically or inductively coupling the TDC to the light source, continuous detection of the camera's switch-on time can be achieved, which allows the readjustment of the sensor control signals to regain synchronicity and thus ensure a permanent high measurement accuracy without a complex calibration procedure. This synchronization mechanism is also required when using SPAD cells. The TDC is able to measure a time interval by combining the rising edges of a start and a stop signal and is covered in depth in different works [4].

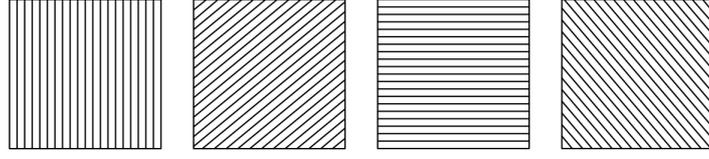


Fig. 4. Linear polarization filters with an orientation of 0°, 45°, 90° and 135°

The polarization filters are realized by the existing aluminum metallization of the CMOS process. As shown in Fig.4, these are metal strips placed over the photodiodes at the smallest possible spacing and width which the process allows, at angles of 0°, 45°, 90°, and 135°, respectively. With the help of the intensity of the light I_0 , I_{45} , I_{90} and I_{135} which passes through the polarizing filters, the Stokes parameters can be determined via the following equations:

$$S_0 = \frac{1}{2} (I_0 + I_{45} + I_{90} + I_{135}) \quad (5)$$

$$S_1 = I_0^2 - I_{90}^2 \quad (6)$$

$$S_2 = I_{45}^2 - I_{135}^2 \quad (7)$$

The Stokes parameters are then used to calculate the Polarization angle

$$\vartheta = \arctan \left(\frac{S_2}{S_1} \right) \quad (8)$$

and the degree of light polarization

$$\text{DoLP} = \frac{\sqrt{S_1^2 + S_2^2}}{S_0} \quad (9)$$

5. Integration and Readout of SPAD Cells

SPAD cells are avalanche diodes which are operated in Geiger mode, at a reverse voltage above the breakdown voltage. If a photon is absorbed in the space charge zone of the diode, an electron-hole pair is formed with a certain probability, which causes an avalanche effect by impact ionization and increases the number of free charge carriers and thus drastically increases the current through the diode [5]. By external circuitry, which in the simplest case may consist of a series resistor, the diode's bias voltage is reduced, which causes the avalanche effect to cease and affords for the detection of further photons in the diode after some dead time. SPAD cells are characterized by high sensitivity and short charge collection times. Therefore, they are particularly suitable for beam-steering and Flash LIDAR applications, where either very long or very short distances have to be measured. In the framework of this project the production of a 16x16 matrix and a TDC based readout is planned.

6. Conclusion

ToF 3D imaging is a key technology for the implementation of autonomous driving functions. Particularly challenging is the measurement with high accuracy and the measurement of long distances which both are addressed in the context of the project. Moreover, polarization information, can support the algorithms for autonomous driving and reduce the computational load. In industrial sensor technology, integrated polarimeters in quality inspection can make material stresses visible that are undetectable to the normal eye or with conventional optical measurement methods. When the sensor is irradiated with linearly polarized light, it can serve as an optical angle or speed sensor for rotational movements. Simultaneous distance and angle measurement could detect the speed of a superimposed translational and rotational motion.

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BIOMEDICAL APPLICATIONS WITH THE USAGE OF VIRTUAL REALITY

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Abstract: *Last years the implementation of the virtual reality applications has been increased in different areas and one of them is rehabilitation of the patients in orthopedics. In the paper the authors give an overview of the variety of virtual reality applications in the healthcare and present the prototype of the application for the rehabilitation with the usage of the Oculus Rift helmet.*

Keywords: bioengineering, virtual reality, medical informational systems, rehabilitation application

1. Introduction

Virtual reality (VR) is a computer environment with scenes and objects that seem real, so that the user feels immersed in their surroundings. This environment is perceived through a device known as a headset or virtual reality helmet.

Implementation of the Virtual reality (VR) in healthcare is increasing each day as in the hospitals as for the educational purposes. It is confirmed its efficiency in orthopedic rehabilitation [1-4]. Despite this fact it's not really a lot of available applications in the market. The object of the research is the processes of physical rehabilitation of a person with the help of a software application using Oculus Rift virtual reality helmet [5].

2. Medical Informational Systems Application and Architecture

Medical informational systems are application which aimed to collect, store, transform and analysis the information related to the health of individuals or to the activities of an organization that work within the health sector [6].

The mostly commonly known Medical Informational Systems are:

- EHR (Electronic Health Record) & EMR (Electronic Medical Record);
- Clinical Information System (CIS);
- Practice Management Software (PMS);
- Patient Portals;
- The Master Patient Index (MPI);
- Remote Patient Monitoring;
- Clinical Decision Support Tools.

The global healthcare VR market is increasing each year. Application of VR in the healthcare [7]:

- VR for Medical Education;
- VR for Medical Training;
- VR for Surgery;

- VR for Pain Management;
- VR for Rehabilitation;
- VR for Stroke Rehabilitation.

VR applications need additional equipment such as head-mounted display [8], smart glasses [9] and haptic gloves [10]. Each of these devices has wide variety of applications of different purposes. The general architecture of the VR application contains 3 main layers – user application, administration panel and server with models and scenarios (Fig.1).

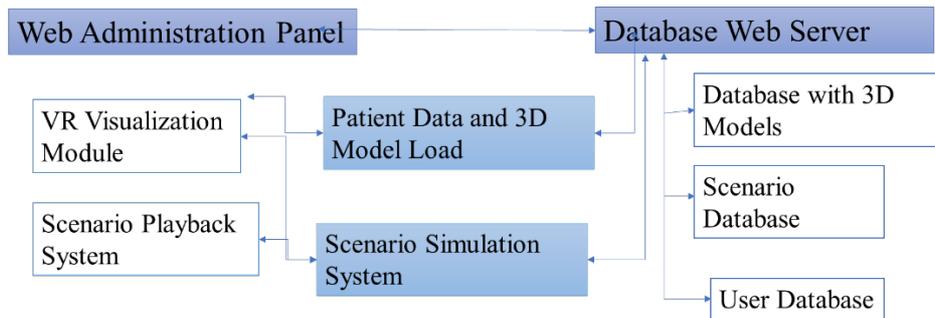


Fig.1. Characteristics of the VR applications for HealthCare [11]

The user application implements the interactive interface concept [12]. This interface should provide the users with the sufficient audio and visual feelings receiving and storing feedback from the sensors. And its include quite comprehensive m2m component.

3. The Concept of Physical Rehabilitation Application

To develop the VR-application, Unity was chosen because of its certain advantages, namely: a large number of Asset and the use of the C# programming language (Fig. 2).

With Oculus Touch controllers, we can track the position of patients' hands by reading their position relative to the helmet. Also using combinations of buttons and joysticks a person can train fine motor skills of hands. Thus, while creating an application, it is necessary to develop such tasks, which will involve the manipulation of objects that require a certain position of the hands and are controlled by a combination of buttons.

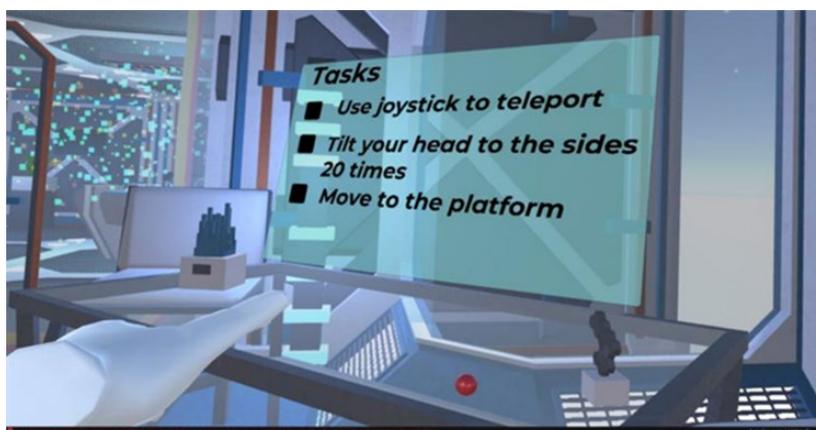


Fig.2. Example of the application interface

Let's consider two use-case scenarios. The first scenario is changing the user position:

Use case: changing the position of the user in the scene using a teleport.

Actor: patient

Preconditions:

- Oculus Rift is connected and working correctly;
- The application is up and running correctly;
- Third-party apps are allowed in Oculus settings.
- Post conditions: the user is moved to the teleportation point.

Main scenario:

- The user points the "laser" of the controller at the teleporter.
- The user squeezes the trigger.
- The application runs the script to move the character.
- The camera changes its position on the stage.

Alternative scenario:

- If the teleport does not work correctly, the user "stays in place".

The second scenario is task tracking:

Precedent: tracking task performance.

Actor: patient.

Interested person: application.

Preconditions:

- Oculus Rift is connected and works correctly;
- The application is running and working correctly;
- Third-party applications are allowed in Oculus settings.

Post conditions: the user performed rehabilitation exercises.

Main scenario:

- The user points the controller's "laser" at the object with the task.
- The user pulls the trigger.
- The application opens a stage for performing exercises.
- The application works out a script that tracks the position of the patient's hands and head, as well as counts the number of times performed for the exercise.

Alternative scenario:

- If the exercise is performed incorrectly, a message and instructions on how to correct it are displayed.

Developed application was tested at the computer with following specification:

- graphics card: NVIDIA GTX 1060 / AMD Radeon RX 480 or higher;
- alternative graphics card: NVIDIA GTX 970 / AMD Radeon R9 290 or higher;
- CPU: Intel i5-4590 / AMD Ryzen 5 1500X or more powerful;
- RAM: 8 GB or more;
- video output: HDMI 1.3 compatible video output;
- USB ports: 3 USB 3.0 ports and 1 USB 2.0 port;
- OS: Windows 10.

4. Results and Conclusion

The purpose of this work is the development and software implementation of a rehabilitation application that allows to monitor the correctness of the exercises performed by the patient.

VR application in Healthcare is set an important place and predicts to set the 3d place among investments in healthcare applications. Development of the VR application should be a part of the curricula.

The Architecture of VR application contains 3 main elements: client VR application, database (with 3D models, scenarios and users) and administration web-panel.

For rehabilitation VR could be used for neurological rehabilitation, physical therapy, cognitive rehabilitation.

Development and testing of Biomedical application should be in close cooperation with the medical personal.

The work is partly done within the framework of international projects «Innovative Multidisciplinary Curriculum in Artificial Implants for Bio-Engineering BSc/MSc Degrees» [BIOART] (Ref. no. 586114-EPP-1-2017-1-ES-EPPKA2-CBHE-JP).

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ARCHITECTURE OF INTELLECTUAL INFORMATION AND TRAINING SYSTEM

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Abstract: *Development of an intellectual system allows you to organize an effective learning process. This article shows the architecture and stages of development for system. The use of various notations is explored, with a focus on UML, and the role of architecture and detailed design specifications are considered. The work also used the nonparametric method of statistical analysis, the Mann-Whitney criterion. The criterion is designed to check the reliability of the differences between two independent samples by the level of the feature, measured on the order scales.*

Keywords: intellectual system, UML, diagrams, stages, architecture

1. Introduction

The experience of many years of work of universities and centers of postgraduate education shows that in the system of continuing professional education, individual training is the main demand, and the main limitation in solving the problems of individual education is time. In the system of advanced training and retraining, the time factor is mainly manifested in the discrepancy between the terms of the specialist's need to study the material with the announced official schedule of classes in educational institutions. Another important aspect of this issue is the content of the announced training programs, which do not take into account the individual needs of future students. At this time, the intellectual system for education is relevant. The creation of an intellectual information system will help improve the quality of education through an individual learning path. To do this, it is necessary to develop the architecture of such a system, which is the purpose of this article.

Active learning in which an element of group discussion is incorporated is being attempted in classes at institutions of higher learning such as universities [1]. These efforts are aimed at using discussion to cultivate problem finding and problem-solving skills and educate the future global workforce. e-Learning systems are vehicles that pro-mote such efforts [2]. The mode of traditional education is transforming with, for example, the rise of massive open online courses (MOOC) for which use has begun in the United States and JMOOC (Japan MOOC) [3, 4]. In this new mode, learners use an e-Learning system such as a MOOC to study content in advance, and then gather in a classroom to hold a group discussion to apply their accumulated knowledge. This type of class method is called a flipped classroom because the order of the class is the opposite that of a traditional class [5].

2. Stages of Information System Development

The system development methodology consists of the following stages:

1. Identification;
2. Testing;
3. Conceptualization;
4. Learning process.

The sequence of steps for building an information system is shown in the Fig.1.

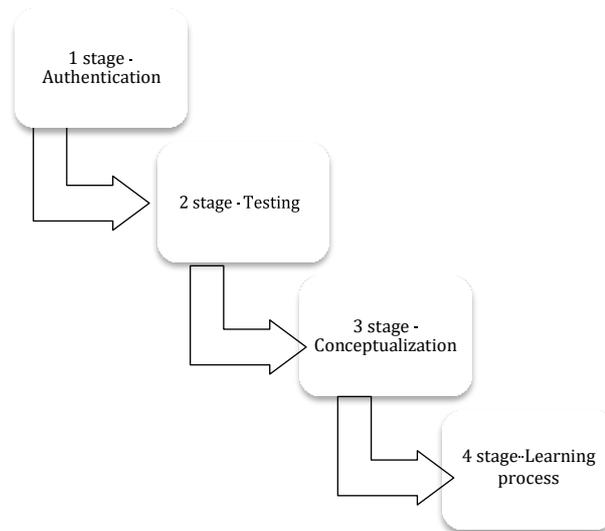


Fig. 1. Stages of development

2.1 Authentication Stage

The authentication stage begins with the user's registration. Next comes the authorization and authentication process. Based on the authentication factors, the user ID is determined. In the information and training system, the identification option is the user identification, and the authentication factor is a username and password. The result of the identification, namely the ID, is the user's login.

2.2 Testing Stage

During this stage, the knowledge is checked and the type of perception of the user is determined. After the identification stage, the system offers courses to pass. When selected, a test is given to determine the level of knowledge for a certain course. For example, when choosing an Educational Practice course " Fundamentals of Information System", the test consists of 28 questions, which includes all 15 topics for this course. The database stores 102 questions, with 10 questions for each topic, including 3 types of question difficulty and 5 answer options. Example of a database of questions:

\$\$\$0030 Aims to mastering of physical, spiritual, and intellectual self-development approaches, emotional self-regulation and self-support by student

- A) Value-sense competency*
- B) Socio-labor competency*
- C) Informational competencies*
- D) Actors and use case diagram*
- E) Personal self-improvement competency*

{Correct answer}=E

{Complexity}=2

{Topic}=12

On this question, you can understand that 1 question is given 5 possible answers, where the correct answer is only 1. Difficulty - 2 and topic-12. The questions assume 3 types of complexity: 1 - easy, 2 – medium, and 3 – hard. Basically, users were given questions on the average and difficult level on each topic in a random order. If the user answered the average and difficult question correctly, then he moved on to the next topic. That is, if the user answered correctly the 1st medium-difficulty question and the 2nd difficult-difficulty question, then the user was asked to start with the topic where he did not answer correctly. Thus, the user is only given the content that he does not know. And the topics that the user knows can also be viewed, but there will be no such topics in the learning path.

2.3 Conceptualization Stage

At this stage, a meaningful analysis of the problem area is carried out, the concepts used and their relationships are identified. This stage ends with the creation of content for the educational system and the domain model, which includes the main concepts and relationships. At the stage of conceptualization, the following features of the task are determined: types of available data; source and output data; applied hypotheses; types of relationships between objects. The information system for education has 19 entities and their relationships. There are two approaches to the process of building a domain model at the conceptualization stage:

1. The attribute or attribute approach presupposes the presence of information received from experts in the form of triples "object-attribute-attribute value", as well as the presence of training information.
2. The structural or cognitive approach is carried out by highlighting the elements of the subject area, their interrelationships and semantic relations.

2.3.1 Attributive Approach to Building a Domain Model

A feature-based or attribute-based approach. The attribute approach is characterized by having the most complete information about the subject area: about objects, their attributes, and attribute values. The idea of the method is that rules (combinations of attribute values) are constructed to distinguish one object from another.

2.3.2 Structural Approach to Building a Domain Model

The structural approach to the construction of the domain model involves the allocation of the following cognitive elements:

3. Concepts;
4. Relationships;
5. Meta- concepts;
6. Semantic relations.

Concepts of the subject area. The concepts of the subject area should form a system that has the following properties:

- uniqueness (lack of redundancy);
- completeness (a fairly complete description of various processes, facts, phenomena of the subject area);
- reliability – validity-the correspondence of the selected units of semantic information to their real names);
- consistency.

Methods of constructing a system of concepts:

- Local Representation method;
- Method for calculating the utilization factor;
- Method of forming a list of concepts;
- Method for making a list of elementary actions;
- Textual method.

Relationships between the concepts of the subject area. A group of methods for establishing relationships involves establishing semantic proximity between individual concepts. At the heart of establishing relationships is the fundamental category of proximity of objects or concepts.

Meta-concepts of the subject area. Interpretation is usually easier for the expert if the groupings are obtained by informal methods. The establishment of semantic relations between the concepts of the subject area.

The last stage of building a domain model in conceptual analysis is the establishment of semantic relations between the selected concepts and meta-concepts. To establish semantic relations means to determine the specifics of the relationship obtained as a result of the use of certain methods. [6]

2.4 Learning Process Stage

At this stage, the user is provided with content with a sequence based on the semantic proximity of the topics. Each user's content will be unique, because the initial knowledge and type of perception are taken into account. Thus, the learning path for users will be individual.

3. Architecture of System

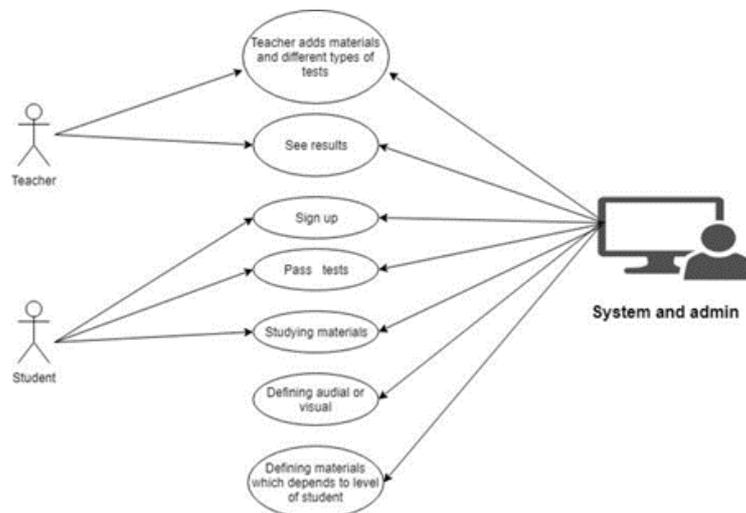


Fig. 2. Use case diagram of the system

Architecture introduces to large systems and how they are partitioned into subsystems and components, as well as how the structuring of these elements into a solution and the interfaces used to join them together facilitates communication and control. Different diagrams address challenges faced by software development organizations when developing large-scale software

systems. The use of various notations is explored, with a focus on UML, and the role of architecture and detailed design specifications are considered from the perspective of risk management. [7]

Use Case diagram is pictorial representation of a collection of tasks and users. Give an overview of how the system should interact with entities outside of the system. Use case diagram of intellectual information system shown in Fig. 2.

Sequence diagrams are used to represent how the system should respond to a request. Sequence diagrams show messages sent among objects between object “lifelines” – these are best for understanding interactions among objects. Sequence diagram of intellectual system shown in Fig. 3.

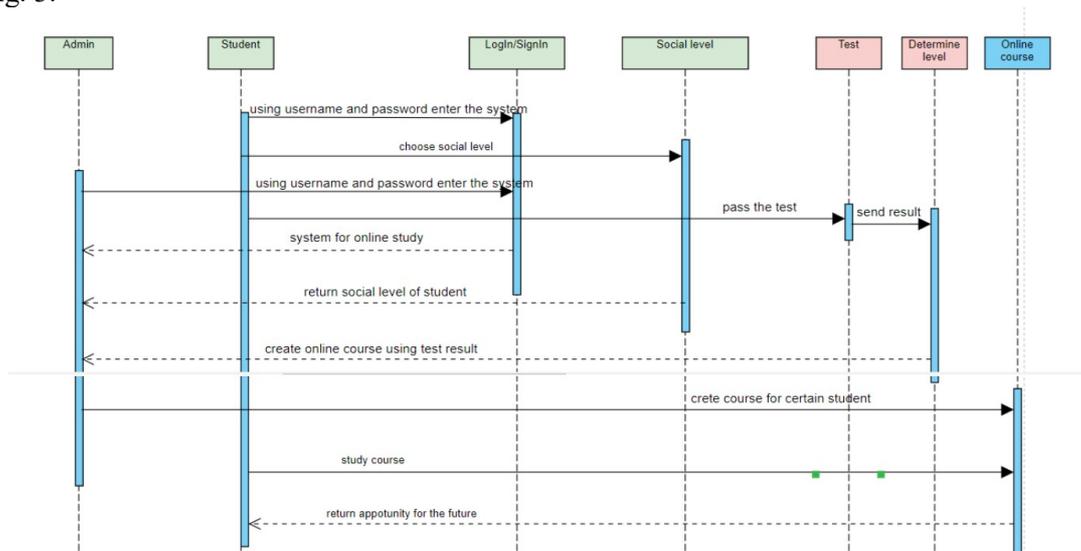


Fig. 3. Sequence diagram of the system

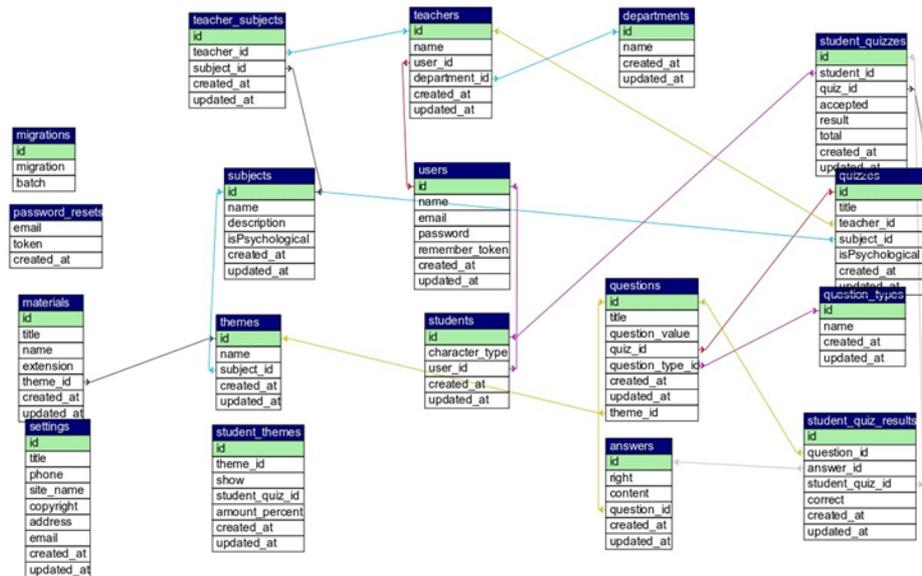


Fig. 4. Entity relationship diagram of the system

An entity relationship diagram (ERD) shows the relationships of entity sets stored in a database. An entity in this context is an object, a component of data. An entity set is a collection of similar entities. These entities can have attributes that define its properties. ER diagram of intellectual system shown in Fig. 4.

Component Diagrams are used to show code modules of a system in Unified Modeling Language (UML). They are generally used for modeling subsystems. It represents how each and every component acts during execution and running of a system program. [8] Component diagram of intellectual system shown in Fig. 5.

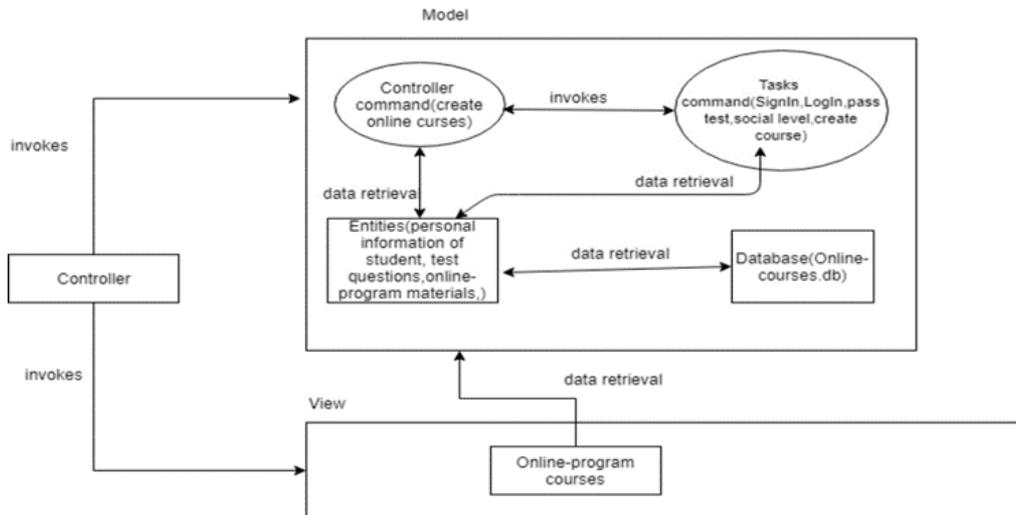


Fig. 5. Component diagram of the system

4. Results and Conclusion

Assessment of the efficiency of using intellectual system. For implementation, 2 groups were created: experimental group (using intellectual system) and control group (using traditional method). The degree of content assimilation is calculated, as shown in Table 1.

The significance of differences between the control and experimental groups was assessed by a nonparametric method of statistical analysis using the Mann-Whitney test (1). The criterion is designed to test the validity of the differences between two independent samples by the level of the attribute measured on the order scale.

The general idea of the method is that the values of the attribute are assigned ranks, and the ranking is carried out simultaneously for both samples. Then, the experimental value of the U - test is calculated from the ranks, which reflects the degree of overlap of the intervals of the rank values in the two samples; the smaller the U_{exp} , the smaller the overlap of the intervals and, therefore, the more likely that the difference is significant. To test the hypotheses, the U_{exp} is compared with a tabular critical value (selected depending on the sample size and statistical significance): if U_{exp} more than $U_{critical}$, H_0 is assumed, otherwise H_1 is assumed. Limitations of the applicability of the U-test:

- 1) the volume of samples must be at least three ($n_1, n_2 \geq 3$); it is allowed to have only two observations in one of the samples, but in the second there must be at least five ($n_1 = 2, n_2 \geq 5$);

- 2) the volume of each sample should not exceed 60 (this is due to the limited critical value tables).

From qualitative or quantitative gradations of a trait, it is often necessary to move on to numbers that characterize the order of gradations-they are called ranks.

$$U_{exp} = n_1 * n_2 + \frac{n_m(n_m+1)}{2} - R_m \quad (1)$$

where, n is the number of students in the group,

R – the sum of the ranks in a certain group,

R_m – maximum value of R ,

$U_{critical}$ - critical value of the Mann-Whitney U-test. [9]

TABLE I. Calculations of Assessment of the Efficiency

No	Group	Name	Point	Rank	General number
1	1	7 student	26	1	1
2	2	2 1 student	28	2	2
3	1	4 student	45	3	3
4	2	2 2 student	50	4	4
5	1	13 student	52	5	5
6	2	2 3 student	55	6,5	6
7	1	2 student	55	6,5	7
8	2	2 4 student	57	8	8
9	2	2 5 student	60	10	9
10	2	2 6 student	60	10	10
11	1	15 student	60	10	11
12	2	2 7 student	63	12,5	12
13	1	8 student	63	12,5	13
14	2	2 8 student	65	16	14
15	2	2 9 student	65	16	15
16	2	2 10 student	65	16	16
17	1	1 student	65	16	17
18	1	17 student	65	16	18
19	2	2 11 student	66	19	19
1	2	2 12 student	68	30,5	20
2	1	16 student	68	30,5	21
3	2	2 13 student	70	23	22
4	2	2 14 student	70	23	23
5	1	3 student	70	23	24
6	2	2 15 student	75	26	25
7	1	5 student	75	26	26
8	1	11 student	75	26	27
9	1	18 student	78	28	28
10	2	2 16 student	84	29,5	29
11	2	2 17 student	84	29,5	30
12	1	14 student	87	31	31
13	1	9 student	89	32,5	32
14	1	19 student	90	34	33
15	1	6 student	91	35	34
16	1	10 student	92	36	35
17	1	12 student	97	37	36

$n_1 = 19$; $n_2 = 17$; $R_1 = 409$; $R_2 = 281,5$; $R_m = 409$; $n_m = 19$; $U_{exp} = 104$; $U_{critical} = 123$

In our case, $U_{\text{exp}} < U_{\text{critical}}$ therefore, it is accepted H_1 – there is a significant difference in the levels of assimilation in the compared groups.

In group 1, they coped with the proposed task faster.

It was found that in the experimental group the degree of assimilation increased by 0.62 points, and in the control group it fell by 0.13 points. The effectiveness of training with the use of IS is 1.15 times higher.

Verification of the reliability of the obtained results showed that in the expert group, the result of the analytical re-cut will lie in the area: from 3.53 to 4.15 points, and in the control group: from 3.2 to 3.33.

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LEADERSHIP IN APPLICATION OF AGILE PROJECT MANAGEMENT METHODOLOGY

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Abstract: *The development of project management systems, programs and project portfolios supports the global acceleration of innovation. Significant changes in the environment require additional research on the effectiveness of the application of existing Agile methodologies, knowledge systems and competencies of project managers and their leadership. The foundation of environmental change lies in changing the decision-making paradigm in Agile project management and innovation development programs. The article examines modern approaches to the formation of leaders in the application of Agile methodologies of its specificity in terms of decision-making processes in project management. The problems of formation and support of leadership in the application of Agile project management methodologies for the creation and implementation of information and communication systems are considered. The research was conducted based on the application of the competency approach based on the model of the International Project Management Association. A meaningful model of competence of a leader who uses Agile management is given. Behaviours patterns of Agile leaders and leaders are formed in the system of behavioural competencies in project management based on the methods and tools of Agile technology. Such competencies included: Self-reflection and self-government, Personal integrity and reliability, Personal communication, Relationships and interaction, Leadership, Teamwork, Conflicts and crises, Ingenuity, Coordination, Focus on results. Patterns of the behaviour of project managers as Agile leaders in project product creation and Agile project management are studied. The studied differences between the patterns of behaviour of leaders and Agile leaders are conducted on the elements of behavioural competencies within the identified key indicators of competence. Such patterns allowed the authors to identify bottlenecks in the application of Agile project management methodologies in the dynamics of the development of innovative products and information and communication systems.*

Keywords: leadership, Agile management methodologies, project, competence, behaviour pattern, project manager

1. Introduction

The fleeting world needs a new kind of leadership and leadership. This thesis emphasizes the dynamism and innovative orientation of projects and development programs of organizations based on the introduction of information and communication technologies. As the world transforms rapidly, a new generation of leaders is needed. That is - people who can respond quickly to technological innovations, changing social relations and creating new businesses and technologies for projects. The challenges that organizations face in developing and implementing information and communication technologies are becoming more complex than ever. Thus, the application of proven best practices is no longer a way forward. The world has realized that planning everything makes us rigid, not Agile. When a project starts with focusing on what is valuable to our customers, we just need to use best practices. Complexity and uncertainty also require another form of control. Responsibility will now be manifested at lower levels within the organization. Decision-makers are increasingly accountable to experts, and leadership is being

replaced by leadership at all levels of the organization. This means that more and more often project teams choose a holacratic, one-tier structure and principles of activity [14]. One of the answers to these challenges is cost-effective work with innovation, an important part of how we organize our activities. Organizations are increasingly taking a value-based approach and learning to distinguish between what is valuable and what doesn't matter, a development that has taken place over the last decade [6]. Many organizations have taken the first, sometimes bold steps in a cost-effective transition to becoming more adaptable to the environment. Today, there are almost no organizations that do not use (at least on an intuitive level) Agile methodologies for project and program management. Organizations that already have experience with Agile methodologies know that more is needed than just sending people to study. They understand that Agile methodologies are easy to learn but difficult to implement in practice. In this case, we need professionals who lead the overall learning process and inspire employees in their organization to adopt Agile thinking.

An analysis of recent research and publications shows that leaders in Agile organizations are embracing change, and this has implications for the strategy they use to achieve their goals and vision. Vision is more of a "blurred spot" on the horizon than a "clear point." With an Agile strategy, the organization can seize opportunities and avoid threats. Agile leaders and leaders understand that such a strategy is blurred, and is the initial stage, a tool to give meaning to the work performed by the organization [1, 15].

An increasingly complex world and an uncertain future present an organization with huge problems. On the one hand, they need to fight waste as much as possible (thrift philosophy), and at the same time, they need to become more mobile. The latter is possible only if people are also universal [2].

Today, there are new ways to work on creating project products, in which decision-making takes place as close as possible to implementation and as late as possible, as justified by the requirements of short life cycles of projects and products in their implementation. Agile management focuses on creating balanced value, not on a planned schedule. The work is performed in the form of short cycles, instead of the introduction of the "waterfall" approach, and constant attention is paid to development and quality [12].

Although there are framework models that provide a certain direction of development, each organization has its interpretation of Agile work. Agile work is a philosophy, it is the foundations that support such a philosophy. Instead of implementing Agile methodologies, people become Agile, and this requires a fundamental change in thinking and leadership. Thus, even plan-oriented projects can also benefit from flexibility [6].

Flexibility determines how the structure of the organizations themselves changes greatly. In this case, each form has its frame of reference or development paradigm. Modern organizations no longer share power from top to bottom, but associate it with certain roles in such a way that there is a significant level of correction. An example is a transition to flat organizational structures with holacratic management. It is difficult for leaders who use different paradigms of development to exchange ideas with each other. Therefore, the Agile leader must be able to move freely between these paradigms [10].

Loss prevention, thrift and balanced value creation do not stop at the boundaries of a team or organization. Agile managers know and consider the context in which they operate. Accordingly, observance of laws and rules is mandatory for the leader. In addition to complying with laws and regulations, they are also aware of the interests of society [12].

There are four types of values in Agile:

- people and interaction between them;

- working product;
- cooperation and building partnerships with the customer;
- readiness for change.

Agile teams foster a culture and values in which participants agree with each other on how they will interact with each other. They encourage individual members to adhere to this and do not always allow their interests to prevail.

Non-violent interaction is the basis of Agile leadership. If force is used, it is done with caution. If there is such a thing as power, then it exists to serve various stakeholders in the organization. This does not mean that an Agile leader can afford to use pressure in all directions; on the contrary, he must provide influential and inspiring leadership [2].

Different influences and interests ultimately lead to balance, and an Agile leader unites the team, not divides it. This can only happen when he demonstrates a genuine and honest interest in various stakeholders. The leader approaches the differences with interest and thus develops the necessary sensitivity to involve these parties with him in Agile thinking.

Culture is the result of the lessons learned by the organization during its life cycle. This is the way it protects its core values. Organizational culture, which is embedded in one (or sometimes several) national cultures (culture), protects the organization from threats and ensures stability. It is the culture that often changes complexity and, consequently, moves to the use of Agile methodologies [13]. Therefore, change of leader is almost always a destructive process. A leader who forms an Agile culture (change) is more important than processes and structures, by its nature assumes the exemplary role of promoters of this culture. Various Agile structures also refer to values such as commitment, courage, focus on values, openness and respect. Basic, often unconscious, basic assumptions within an organization do not always reinforce each other. Culture is changing gradually. It is not self-evident that everyone feels comfortable with these changes. People leave the organization and new members join. Every Agile leader takes this into account.

The purpose of the article is to consider the problems of forming and maintaining leadership in the application of Agile project management methodologies for the creation and implementation of information and communication systems.

2. Research Methodology. Competence Model of Agile Leaders' Behaviour

The competency approach is based on two concepts:

- competence is an area of activity or function performed by an employee;
- competence is a characteristic of the potential ability of the employee to carry out successful activities within certain competencies [13].

Modern organizations face an urgent task: to reveal the competence potential of specialists in full, which is extremely important for making the right management decisions and conducting a reliable examination during the project. However, it must be remembered that for every employee who develops his career in the organization, such development is, on the one hand, a motivating factor, on the other - a threat. At the same time, each employee is expected to learn to manage their competencies and develop them based on Agile leadership. Successful implementation of innovative projects and programs to create modern information and communication technologies is ensured by the creative application of the competency approach. This approach can be used as a common language of communication that brings together the organization and employees, tasks and performers based on Agile leadership. In this case, the development of the organization and staff development occurs simultaneously. Personality develops during the interaction between

people. Someone recognizes themselves concerning others. Reflecting, we study the impact of our behaviour on others. The tension that sometimes arises motivates us to adapt, which is the value of self-government. Thus, this element of competence is the basis through which a person develops individual flexibility [13].

The agile leader has a mentality of growth, a belief that he can develop further due to the acquired competence that he develops in the organization. This mentality is the responsibility of the individual, who must act based on his inherent motivation, and not through external pressure. The focus is on the personal development of each person. There is an expectation that everyone will take this way of behaving like a leader. That is why it is important to provide working levels of stress, and this work is an important source of happiness [3].

The agile leader will act following his inner motives, so he retains his integrity. Allowing team members to do the same (act according to internal motives) makes it reliable and inspiring. Nothing is more unpleasant than a leader who imposes Agile methodologies but does not work according to Agile principles. The professional values of an agile leader are rooted in Agile thinking. Therefore, ethical behaviour operates following Agile principles. The choice of Agile methodologies means that management will accept its employees as they are unconditional. After this choice, managers must demonstrate Agile leadership and leadership. This means that team members are provided with resources to do their jobs. Besides, the general interest of the team must take precedence over the individual interests of its members. Only then will the leadership be trustworthy and reliable.

One of the principles of Agile work is the joint creation of products, projects and programs. Therefore, personal communication is the most rational and effective way to share information with the team and within it. This makes conversation the most important form of communication. An agile leader does not represent, but supports the group and creates a social network in which people meet and talk to each other. This is one of the main tasks of an Agile leader. It requires everyone to be actively present in the conversation, as a result of which we limit misunderstandings and make it debatable. Leaders set the example. Since this is not self-evident, it is not taken for granted. In this case, each other communicates non-violently because of certain behaviours. This creates an open space in which everyone is involved in the process and can be present [1].

An open attitude to people and events makes information freely disseminated within the organization and leads to the prosperity of relations between team members. It is necessary to ensure self-determination and flexibility. Everyone in the organization must have the right information at the right time to make an empirically sound decision.

Openness is the clarity and transparency of the project and organizational goals to be achieved, the results and the assessments of progress. It is about cooperation and agreements, as well as the beliefs and fears of individuals that affect the relationship. Openness means providing transparency and asking questions while postponing judgments. This creates trust and confidentiality. Agile leaders are an example to follow. Self-knowledge makes it possible not to follow one's selfish needs for dominance in relationships with others. The ministry and aspects of relationship management must be in balance [5].

An Agile organization is a social network that in turn leads to self-observation. The composition of this network is dynamic, but people give clear agreements on how they work together. Agile leaders give direction to part of the network, but as an assistant, not as a ruler. They build relationships in which the other creates an understanding of what is going on around him to make his functioning in the network more valuable. This increases the social capital of an Agile organization [12].

There is a difference between a manager and a leader, a manager has a hierarchical position, a leader has certain skills to motivate people and to set everything in motion. In this element of competence, leadership is defined as a characteristic, not as a managerial function. Many people can demonstrate leadership, but only a few are managers.

Agile is based on equality, autonomy and self-determination. The personal leadership of people in such an environment is crucial for choosing the direction, motivation and assistance of people so that they can achieve the desired organizational goals. The leader takes the position of an assistant whose interests of the group or organization are central. The leader does this primarily by setting an example and helping to build relationships with the people he leads or works with. The degree of self-determination that a team receives depends on their skills and abilities. The quality of leadership is determined by the level of integration of specific team members to achieve project goals. An agile leader is one who proactively removes obstacles and allows teams to deliver value.

Within an Agile organization, the focus is on collaboration between individuals, teams, and clients. Team members are partners, not employees. Self-study groups play a crucial role in an Agile organization. Each team has a goal, but its priorities are to always benefit the organization and its customers. This is manifested in trust, conflict resolution skills, commitment, accountability and focus on common goals, the willingness of individual team members to work flexibly. Without imposing from above, they share specific goals and constantly make agreements about how they work with each other. This does not prevent the agile leader from challenging the team to constantly improve.

Team members together have all the experience and skills to achieve the project goal. Preferably, the individual members are interdisciplinary, so the teams are more independent, not very large and therefore more agile and responsive. They challenge each other, share knowledge and teach each other, which makes them more widely deployed and Agile. For optimal cooperation in the team, an important factor is a diversity, as well as different characters of team members.

The Agile leader takes care of the favourable working environment and conducts the right types of meetings and workshops. During them, be it "stand-up" meetings, seminars, large-scale discussions, etc., he takes a neutral position as a facilitator.

Conflicts arise within the team, but also in collaboration with other groups and stakeholders. Where people work together for a longer period, conflict is a means of strengthening ties, perceived as inevitable, and seen as an opportunity to learn.

To turn conflicts into a constructive direction, the agile leader provides an environment in which conflicts can be used to benefit the team. That is, it is agreed in advance how differences are motivated when they arise. Sometimes Agile principles and how they are used in everyday practice become a source of conflict. An agile leader encourages the people involved to find common ground. As a result, the team develops its own skills for resolving the conflict.

Despite all preventive measures, sometimes it is impossible to avoid a crisis. Every crisis is a situation that requires optimal flexibility. A team looking at its iteration-to-iteration collaboration will also be well prepared for the next crisis. However, this is not enough; the threat of a crisis requires a well-thought-out critical plan. At the end of the crisis, there will be a need for retrospect [12].

The ingenuity of performing Agile work is expressed in the provision of results with limited resources. The phrase "ingenuity, not resources" is a great expression of this. Initially, people and

teams look for the solutions or resources they need without expecting them from others (such as senior management). Agile leader stimulates the development of creativity. For example, he does this by working in a safe environment where people can experiment in addition to using known technologies. It is also inferior to people with different views who violate existing patterns to stimulate group blindness [1].

In particular, self-study organizations expect individuals and teams to agree on solutions when there are differing opinions. This requires negotiation skills. The agile leader facilitates this process. Negotiations are also aimed at achieving the maximum balanced value for all stakeholders. It is important to remind different parties about this again and again.

In an Agile environment, people have to negotiate on various issues. Initially, the organization has different ideas about what "Agile work" is. Where an agile leader plays a facilitating role, he must constantly negotiate how to do so in that particular situation. Collaboration style is better than forcing style. There is no single approach, but an individual approach must be developed for each new task. This is done through negotiations. The solutions found to define a new Agile culture [4].

The focus on results is obvious because an Agile organization works cyclically for a short period (iteration) and must achieve results at a continuous pace. The context in which an organization operates is determined by the several ways in which it may manifest itself. Deterministic planning-oriented projects can benefit from this approach by providing results at each iteration [10].

The work environment (Gemba) should give people maximum support in creating project products. Besides, employees create working conditions from which they constantly adjust standards to higher levels. This stimulates the agile leader. Thus, a process of continuous improvement is created, which contributes to achieving maximum productivity [9].

Agile leader knows the purpose and potential of the organization, promotes the formation of effective new teams and increase the efficiency of existing teams. A leader builds a network of business relationships that support their virtual organization.

3. Research Results. Agile Leadership in the Implementation of Innovative Ideas, Projects and Programs

The research was conducted within the ICB4 competency model [13]. Agile leadership is formed under the influence of many factors and within behavioural competencies [13]. The list of such competencies of heads of organizations, project managers and Agile leaders is given in Table 1.

TABLE I. Behavioural Competencies of an Agile Leader

No	Name of competence
1	Self-reflection and self-government
2	Personal integrity and reliability
3	Personal communication
4	Relationships and interaction
5	Leadership
6	Teamwork
7	Conflicts and crises
8	Ingenuity
9	Harmonization
10	Focus on results

The research was conducted on the basis of assessors' assessments and self-assessments of a group of project managers who passed the international certification according to the ICB4 model according to the key KCI competence indicators, which form the basis of the competence assessment model. The results of the study are shown in Fig. 1.

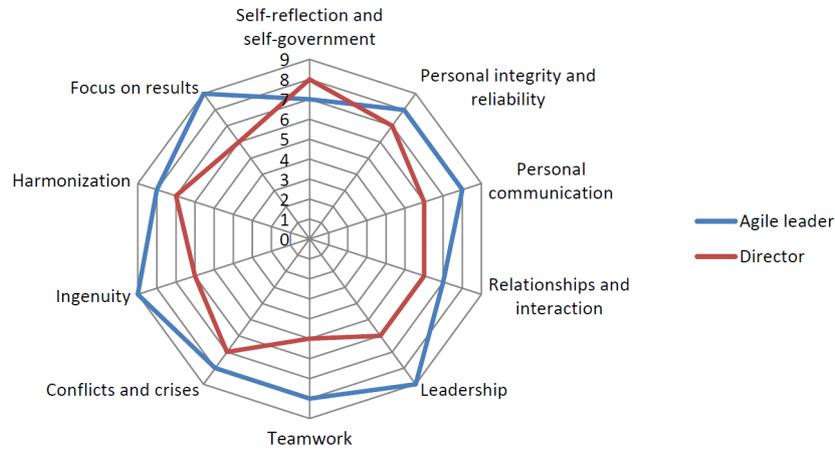


Fig. 1. Patterns of the behaviour of an Agile leader and a leader in behavioural competencies

The study involved 10 specialists who were certified according to the ICB4 model [13]. Individual assessments of patterns of behaviour of Agile leaders and managers are obtained.

The average values of competency assessments were taken as the basis for constructing a pattern of behaviour of an Agile leader, which together with the assessments of managers is shown in Fig. 1.

TABLE II. Expert Assessments of the Behavioural Competencies of the Agile Leader

Agile leaders. Competences	Experts										Average	Variance
	1	2	3	4	5	6	7	8	9	10		
Self-reflection and self-government	6	7	8	8	6	6	8	6	7	6	6,8	0,92
Personal integrity and reliability	8	9	8	8	8	9	7	7	8	6	7,8	0,92
Personal communication	9	7	8	8	9	8	8	8	7	8	8	0,67
Relationships and interaction	8	9	8	8	6	9	9	8	8	8	8,1	0,88
Leadership	10	9	9	9	10	10	10	9	10	10	9,6	0,52
Teamwork	9	10	9	8	9	8	8	9	10	9	8,9	0,74
Conflicts and crises	8	9	8	8	9	10	9	8	9	9	8,7	0,67
Ingenuity	10	10	9	10	9	9	10	10	9	10	9,6	0,52
Harmonization	8	9	8	8	7	8	8	9	7	8	8	0,67
Focus on results	10	9	10	9	10	8	10	9	9	8	9,2	0,79

Table 3 presents expert assessments of behavioural competencies of heads of organizations.

TABLE III. Expert Assessments of the Director's Behavioral Competencies

Agile leaders. Competences	Experts										Average	Variance
	1	2	3	4	5	6	7	8	9	10		
Self-reflection and self-government	9	7	8	8	9	9	7	8	7	8	8	0,82
Personal integrity and reliability	7	8	7	7	8	6	8	6	6	7	7	0,82
Personal communication	6	7	6	5	6	5	7	6	5	6	5,9	0,74
Relationships and interaction	6	5	7	5	6	6	5	6	7	5	5,8	0,79
Leadership	5	6	6	7	5	5	7	7	6	7	6,1	0,88
Teamwork	6	5	5	4	6	4	6	4	5	4	4,9	0,88
Conflicts and crises	7	7	6	7	8	6	8	6	7	7	6,9	0,74
Ingenuity	6	6	6	5	6	6	7	5	6	6	5,9	0,57
Harmonization	7	7	8	8	7	6	6	8	7	6	7	0,82
Focus on results	6	7	6	6	6	6	5	6	7	6	6,1	0,57

From the results of the competence assessment, we see that almost all elements of the competence of Agile leaders except for "Self-reflection and self-government". The key indicators of the competencies of the element of self-reflection and self-management of an Agile leader are given in Table 4.

TABLE 4. Key Indicators of Competencies of the Element "Self-reflection and Self-government"

No	Key competency indicators
1.1.	Identifies and reflects on how one's values and experiences affect work
1.2.	Creates self-confidence based on personal strengths and weaknesses
1.3.	Identifies and thinks about personal motives to set personal goals and focus
1.4.	Organizes personal work depending on the situation and own resources
1.5.	Takes responsibility for individual learning and development

The analysis of the competence of the leader and the leader in the sample of 20 people allowed the authors to build patterns of their behaviour, which are shown in Fig. 2.

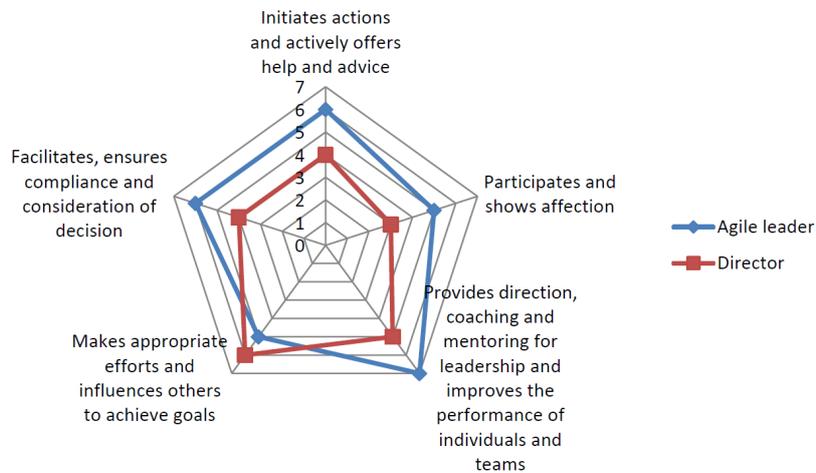


Fig. 2. Patterns of the behaviour of an Agile leader and leader in the competence of "Self-reflection and self-government"

TABLE 5. Key Competency Indicators of the Leadership Element

№	Key competency indicators
5.1	Initiates actions and actively offers help and advice
5.2	Participates and shows affection
5.3	Provides direction, coaching and mentoring for leadership and improves the performance of individuals and teams
5.4	Makes appropriate efforts and influences others to achieve goals
5.5	Facilitates ensures compliance and consideration of the decision

Analysis of the patterns of behaviour of Agile Leaders and Leaders identifies significant gaps incompetence for individual key indicators of competencies. For example, in the competence element "Leadership" according to the key competence indicator "5.1. Provides direction, coaching and mentoring for leadership and improves the work of individuals and teams there is a significant gap between the Agile Leader and the leader (Fig. 3).

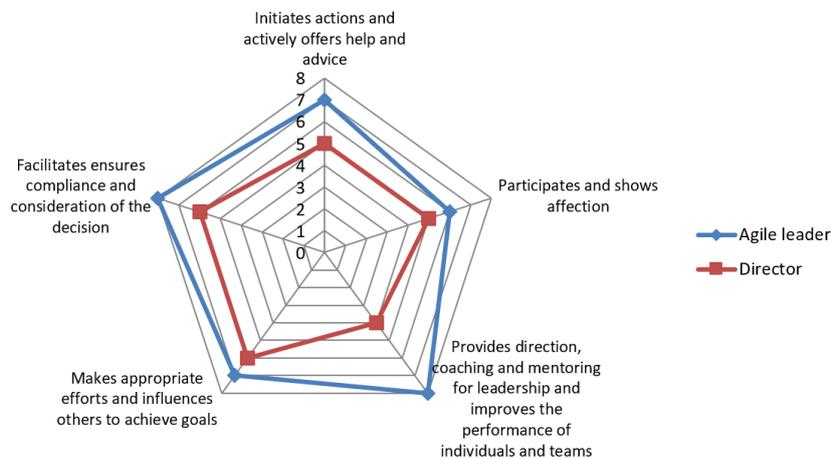


Fig. 3. Patterns of the behaviour of an Agile leader and leader in the competence "Leadership"

4. Conclusions and Prospects for Further Research

As a result of the study, the principles of forming Agile leadership based on the use of Agile tools were identified and analysed. The application of these principles to the development of project management systems, programs and project portfolios allows the success of projects to create information and communication technologies based on properly formed patterns of behaviour of Agile leaders and leaders of organizations. behaviour patterns of Agile leaders and leaders are formed in the system of behavioural competencies in project management based on the methods and tools of Agile technology. Such competencies included: Self-reflection and self-government, Personal integrity and reliability, Personal communication, Relationships and interaction, Leadership, Teamwork, Conflicts and crises, Ingenuity, Coordination, Focus on results. The results of the research proved a significant difference in the patterns of behaviour of Agile project leaders and leaders of organizations.

Further research should be conducted in the areas of analysis of all competencies of project managers, including groups of strategic and practical competencies according to the model [13]. At the same time, it would be necessary to investigate the differences in the patterns of Agile project leaders and heads of organizations for different groups of projects of creation of information and communication technologies and training systems within such technologies.

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SUCCESS-ORIENTED STRUCTURED MODEL OF MANAGING INTERNATIONAL DEVELOPMENT PROJECTS IN GHANA

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Abstract: *International development projects provide socio-economic assistance to the developing countries, and/or to target beneficiaries. The development project creates structures and institutions that synergistically exert influence for development at different levels on the hierarchy of societies. This paper aim is to conduct the literature review on the field of international development project management with special interest to critical success factors and criteria. Eventually, success in each phase provides favorable conditions for the implementation of the rest of the project. As result of the research, proposed success oriented structured model based on IDE0 formalism, which leads to several advantages in development project management.*

Keywords: international development projects, project management, critical success factors, project success criteria, project management modelling, schedule overrun, cost underrun, project outcome, project failure, target beneficiaries, project life cycle

1. Introduction

The progressive mankind envisions a prosperous, inclusive, resilient, and sustainable future for all people of the Earth, while sustaining its efforts to eradicate poverty in the world. For developing countries, transport and energy projects have a known impact on improving living standards and accelerating social and technical economic development. Projects are becoming the leading form of development, so the success of projects, the elimination of rework and excessive consumption of resources leads to a significant impact on socio-economic development. Many studies focus on development projects topic, but only a few with focus on critical success factors and criteria. This research aims to build success oriented structured project management model of international development projects. In addition, link this with adjacent fields such as project resource allocation efficiency, prevents projects overrun and delay, computer based modelling.

2. Literature Review

2.1. Projecting Socio-Economic Progress Opportunities in Developing Countries

The developing economy ensures access to modern, affordable and reliable energy and transportation sources as the underpinning and a pre-requisite for poverty alleviation, proper education, good health care and economic growth prosperity [1, 2]. To do this, it is extremely important to understanding the various ways of achieving energy efficiency and sustainable growth, as well as their key benefits, in order to promote environmental improvement without compromising economic growth [3].

The contribution of infrastructure to economic growth is immeasurable and is well recognized both in academic and policy debates and circles [4]. Roads are Africa's dominant mode of transport and carry over 90% of traffic development in transport systems include both roads and transport services provide opportunities access to various economic and social resources and other essential services. Transportation facilitates the movement of people, goods and services within the country [4-6]. Consequently, any disruption in the various components of the transport system (i.e. infrastructure, operations, and demand) may probably adversely affect on the system efficiency and weaken its impact on the society progress [4, 7-9]. The transport and energy industry sectors are critically important in Ghana's development efforts and mobility prospects. Road infrastructure development in Ghana is seen as a poverty reduction strategy which has a direct link to all the sectors of Ghana's economy, so road transport falls under infrastructure development and has the multiplier effect in creating wealth. Also Ghana has been faced with serious electricity supply challenges in recent times as a result of increasing population, urbanization and economic growth etc. [1, 6-11]. This infrastructure branches lubricates other sectors such as tourism, mining, health, trade, education, agriculture [12]. Projected trends in climate variables and extremes are likely to introduce several risks and uncertainties over the future of the sector's contribution to the country's wider socio-economic agenda [1, 2, 6-11]. Thus, the governments of most developing countries, including Ghana, face the challenge of meeting the growing demand for new and better infrastructure development projects [4, 10].

2.2. The Contribution of Development Project in Socio-economic Progress

After all, development projects of different types mainly aim to reducing poverty and living standards improvement, environment protection, basic human rights protection, assistance for victims of natural or people-caused disasters, capacity building and development of basic physical and social infrastructures [3, 13]. A developmental project can generate or drive other projects and gather actors from different horizons to work towards a common objective. Development projects form a special type of projects that provide socio-economic assistance to the developing countries, and/or to some specially designated group of target beneficiaries [14, 16]. These projects differ from industrial or business oriented projects in several important ways, the understanding of which has strong impacts on how the projects can be managed and evaluated. Even for projects involving development of physical infrastructure and facilities, the ultimate soft goals of serving sustainable development mainly is a priority for the project evaluation by key stakeholders and beneficiaries [13-15].

The intangibility of project goals and deliverables causes the special challenge in managing and evaluating development projects that require adaptation of the existing project management body of knowledge [16, 17]. In such circumstances, it is assumed necessary to adopting new concepts and methods to predict, monitor and measure the extent that the development projects achieve these goals. Not enough attention to the important aspect of development projects usually leads to a tendency to measure only resource applying and effort, which does not lead to success. The projects, including development projects, are temporary [17], their ultimate goal is to make positive and significant changes that will take place after the completion of external assistance. This sustainability requirement adds a new level of intangible development outcomes [16].

For developing countries, transport and energy projects have a known impact on raising living standards and accelerating social and technical economic development. Projects are becoming the leading form of development, so the success of projects, the elimination of rework and excessive consumption of resources leads to a significant impact on socio-economic development [1-5].

2.3. Characteristics of International Development (ID) Projects

International Development (ID) projects have significant roles to play in developing countries. Projects remain the instruments of choice for policy makers and vehicles for international development assistance, in particular still relevant in countries where institutional capacity is minimal [15, 18]. In Ghana and in many other African countries governments' budgetary constraints and insufficient tax collections are impacting on the governments' ability to fund large projects beyond the stimulus packages, which have placed further strain on national finances. Basic infrastructure and affordable services are indispensable in Africa so as to provide the populations with effective access to social services and in order to unlock the continent's investment potential [9-12]. From 1964 to 2003, World Bank infrastructure projects generated a higher social rate of return in transport than in any other sector [4]. For instance, nearly 100 percent of the operations of the International Development Association (part of the World Bank) consist of projects [4, 18]. In terms of poverty reduction, this impact distinguishes ID projects from other projects. Thus, ID projects are not driven by market pressure, and their "end product" results are often intangible and often difficult to measure. However, according to [14], project management ID differs from conventional project management, in which a triangle of cost and time factors is considered crucial [13, 19]. The project management literature is rich in scientific articles published for projects in the construction and manufacturing sectors, but the international development is less represented in the project management literature [13-16]. Current publications show that most ID projects face excess time and costs, and they require special management methods, taking into account the interests of stakeholders, about 75% of the completion of all projects was delayed, but the final costs were lower than planned [13, 20]. However, paradoxically, the poor performance of projects and the frustration of project stakeholders and beneficiaries seem to have become the rule rather than the exception in today's reality. The failure rate of projects in the World Bank and the International Finance Corporation was over 39%. Too often, World Bank projects fail to achieve their goals due to a number of problems: imperfect project design, poor stakeholder management, delays between project identification and launch, and delays in implementation project, overspending, failure of coordination, cannot provide much-needed impact for beneficiaries [4, 15, 20, 21, 22]. Project leaders or coordinators of international development projects deal with complexity, resistance to change, competing programs of a large number of stakeholders and diverse and even conflicting expectations, which make it very difficult to reach compromises [15, 18, 23]. Too often, projects succeed in one place and then partially or completely fail elsewhere, emphasizing the strength of context in the success of an ID project [20, 22]. From this point of view [23] outlined the unique characteristics of ID-projects and identified the impact of interpersonal relationships, trust and communication on the success of the project. International development projects typically involve three separate key stakeholders, namely the funding agency, which pays for but does not directly use the project results, the executive unit, and the target beneficiaries, who actually benefit from the project results but often do not pay for the projects. It should be noted: one of the essential features of most international development projects is the complex interaction of the network, which involves many stakeholders and beneficiaries [13-16, 20].

2.4. Cost and Schedule Performance Challenges of International Development Projects

Project execution over time, cost and volume, and maintaining quality throughout are very common dimensions of success factors mentioned by project management professional bodies and the research community [13]. Thus, the need to understand the reasons for delays and overspending in international development projects has become more important. Significant overspending is realized not only as a result of changes to the order and processing, but also due to security incidents that may occur as a result of these events. For example, in papers [24, 26] showed that when a rework event occurred during projects implementation, the susceptibility to

safety incidents increased significantly, as did the cost of the project. As a rule, the percentage of overrun of planned costs and reduction of costs exceeds the excess of costs and unplanned projects. As for the schedule, on average 84% of projects are late, and over fulfillment of the schedule is almost two years. Late projects take about 39% more time than planned for the average duration [13, 18, 20].

Combining the time and cost of all ID projects, you can see that most projects (73%) are delayed (schedule overruns) and save project cost (cost under estimation). In contrast, only a few projects (13%) are implemented both on schedule (non-compliance with the schedule) and due to savings on budget expenditures (cost reduction) [13]. In Ghana, the duration of development projects from start to finish has recently become a major concern, especially among clients and beneficiaries, due to rising interest rates, inflation, development plan goals, among other factors. Thus, the need to understand the reasons for delays and overrun in the development projects management has become more important than ever [8-11, 27]. The scientific publication on the mentioned topics study facilitates a debate on the factors that cause project overruns and costs in the construction sector, especially from a developing country perspective [27]. In essence, Love et al [24-26]. conclude from their research that overspending is not really a case of "projects that do not go according to plan (budget)" but "plans that do not go according to the project". So let's summarize delays in project completion have become a major challenge worldwide and lead to increased costs invested in the project, which is divided into phrases of long-term, employee productivity, downtime, loss of income and complete abandonment of the project. The duration of project completion has a detrimental effect on customers, contractors, and prospective beneficiaries [25, 28].

However, good planning and implementation with key stakeholders and consultation involvement is needed to prevent project delays and failures. Project planning as defined by PMI [17] refers to the formulation of a project guide that will provide direction on the project implementation and project control towards achieving the success of the project. According to PMI [17], it is seen as a process that is oriented towards bringing desired output, to be recognized as successful [28].

3. The Success Factors and Criteria Effectiveness Concept of Development Projects

Project implementation and success have been one of the most influential and important areas of project management knowledge over the last ten years. The literature argues that both project effectiveness and efficiency should be considered when talking about project success [30-32]. A synonym for success is effectiveness, i.e., the degree of achievement of objectives [31]. Projects are formed to accomplish objectives and success is measured in terms of how well these objectives have been met [32].

Different people in different projects and in different time dimensions view the success of a project differently [33]. This ambiguity in the meaning of "success" is due to the fact that success can be measured by any of several different sets of objectives, project objectives - i.e. what is expected from the project organization at the end of the project (volume, quality, cost, time). general project objectives - i.e. what project owners expect to receive from the use of project results after the project is transferred to them from the project organization, social and environmental objectives - i.e. what benefits the local community expects from the project both during the project and under the project time of use of project results [35]. As a result, project success is not a one-dimensional and static concept, but rather a multidimensional and dynamic one offer a multidimensional concept exploring success from different dimensions: 1. effectiveness; 2. impact on the client; 3. impact on the team; 4. business and direct success; 5. preparation for the future [33-36].

Distinguish between project success (measured on the basis of overall project objectives) and project management success (measured against widespread and traditional performance indicators in terms of volume, quality, cost and time, i.e. project objectives) [35].

The project success criteria correspond to the measures on which the project success assessment is based. Success factors, on the other hand, are the key factors on which the success of a project will depend. In fact, success factors are a contribution to the management system that will lead to the success of the ID project [36]. Therefore, it can be argued that the criteria for assessing success must be adequately defined in advance. Therefore, outside of time and cost, the extent of a project's success or failure will depend on the project's goals and objectives. In addition, success criteria may vary or be weighed differently depending on the stakeholder conducting the evaluation. Each stakeholder will consider success according to criteria that meet their own needs [35, 37]. Thus, the ambiguity in the meaning of "success" is that success can be measured by any of several different sets of goals. It should be added that a good communicative and convincing vision of the project has a strong impact on the perceived success of the project. It should be noted that the importance given to project success criteria and project performance indicators varies depending on the industry, project complexity and the age and nationality of the project manager [35-38].

4. The Success Oriented Life-cycle-based Structured Model of Managing ID Projects

This chapter illustrates the project model based on project life cycle phases, designed to assist in improving the overall performance of an international development project, where predefined sets of factors and criteria provide dynamic links between them. The proposed methodology is based on the formalism of IDEF0 activity diagrams. Therefore, achieving our aim we had to make several adaptations of the conceptual approaches and framework represented [16, 33, 35] to build a model. IDEF0 formalism allows identifying processes and supporting the project management system to achieve project success, taking into account 3 dimensions of success.

Process-oriented success of project management is gradually assessed, breaking down the success of the project life cycle outgoing links (Fig. 1), by input data, activities and output elements of the proposed model, thus measuring the production efficiency of outcomes and achieving the results for each of these phases.

The success of the penultimate phase of project management (Block "A4" on Fig.1), based on the management processes of project performing and all appropriate actions, as well as the adoption of final deliverables and final reports of the project by key stakeholders, which is the cumulative effect of success of all previous stages. The developed model allows, on the other hand, reflecting the success of the project as the effective use of the final product of the project and the sustainable achievement of the project objectives and long-term goals that led to its initiation. It should be assessed at the end of the project according to different sets of criteria, which are based, in essence, on the impacts on development, sustainability and recognition of the project aims of stakeholders and the development community in general. Success criteria for one phase are understood as part of the success factors for the next phase. The formal model we have built allows us to summarize the criteria and success factors for the life cycle phases of international development projects. Fig. 1 represented the proposed model, which includes certain criteria and factors for both project management success and project success in a dynamic system, that combining the phases of the ID projects life cycle management. The sets of criteria correspond to three dimensions of project success: project management success, project success, overall project success.

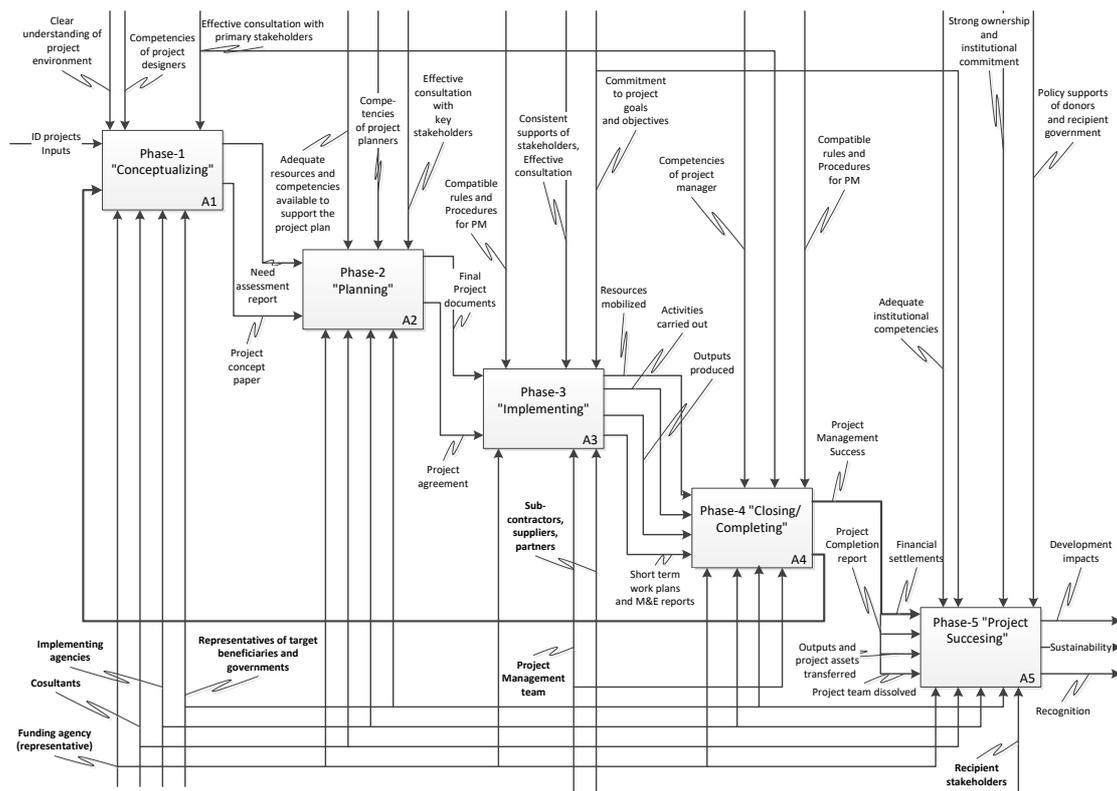


Fig. 1. Life-cycle-based structured model for international development projects management (IDEF0 formalism)

5. Results and Conclusion

In developing/emergent countries transport and energy industry sectors, in particular their interaction and mutual influence, are one of the most weighty, that contributing to the viable socio-economic development. Development projects form a special type serving social and economic development. Evaluating the effectiveness of ID projects is significant since for the other projects, but the evaluation criteria are slightly different. The role separation of three key stakeholders has several important implications. The proposed model provides the project stakeholders and target beneficiaries with a forecasting and diagnostic tool to evaluate objectively the project success, and therefore to assist in improving the overall performance. Therefore, the use of IDEF0 formalism leads to several advantages in development project management. The main ones are: reducing the time required to develop the planning model for new project initiatives; simple formalism that can describe all factors and clarity of information flows especially for stakeholder interaction, donors, development agencies and target beneficiaries.

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COST OVERRUNS IN INFRASTRUCTURE PROJECTS: A REVIEW. THE CASE OF THE SPANISH CONSTRUCTION SECTOR

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Abstract: *Cost overruns in infrastructure construction projects have become a serious economic drawback worldwide, in some cases reaching astronomical levels. Society is following the path to a sustainable development where this inefficient use of resources is not possible. In this paper, a worldwide review of cost overruns research is done, with studies aiming to determine both its causes (like not good enough project design quality) and its quantification (from 10 to even 50% depending on several factors like project complexity). Then, the review focused on Spanish construction sector, showing the relationship between cost overruns and public tender system and law, where contractor companies have based their benefits.*

Keywords: cost overrun, infrastructure project, Spanish construction sector, civil engineering

1. Introduction

The problem of cost overruns in projects, especially in infrastructure construction, has been a cause for world concern for a long time because of its magnitude. Nowadays society demands a sustainable development where inefficient resources expending on project deviations has no space.

Budget increases in an infrastructure project of more than 20% are absolutely unfeasible in a modern society that has sufficient technological means and qualified technical personnel to carry out sufficiently rigorous studies to avoid such excessive deviations.

However, it is showed worldwide that these cost overruns are still happening, with studies such as Catalão et al. [1] who found an average overrun of 17.8% in Portuguese projects (from 1980 to 2012), Love et al. [2] who found that 47% of transport works of the public sector of Hong Kong (320 projects from 1999 to 2017) had cost deviations, with an estimated cost of 13.12 billion euros, or the 22.4% of average cost overrun which Flyvbjerg et. al [3] recorded from European projects.

In Spain, this problem has become generalized in public works, becoming a serious economic inconvenience in recent years, whose amounts sometimes reach astronomical numbers. In the last 15 years, the investment in this type of works has been very high and the budgetary deviations have been proportional, exceeding in some cases the most pessimistic predictions.

Even taking as real the generic data provided publicly, the cost overruns on construction works are at least between 10-20%. Taking into account an annual investment of 10,000 Million Euros destined to the construction of infrastructures, and assuming that an efficient management of the contracts could save only 10% of additional costs, the resulting figure would be 1,000 Million Euros per year. The last one represents a third of the Social Security deficit in Spain in 2014, which in 2018 has been multiplied by 8, despite a decrease of 0.6 percentage points compared to

2017, when it reached its historical maximum. All this gives an idea of the magnitude of the problem [4].

This paper shows a literature review to make a first approach to this problematic. Firstly, studies from all over the world are analyzed, followed by the example of Spanish construction sector. This review will provide the framework for further proposed research on cost overruns in civil engineering projects in Spain.

2. Literature Review

Project deviations, and in particular cost overruns, have been studied all over the world since the start of project management procurements. It is justified because of the society's concern over the inefficient use of resources. This issue becomes more important when it comes to public promotion projects, since they involve the resources of public administrations financed by citizens' taxes. The main example of the type of projects which involve this problematic are the infrastructure construction projects, like transport projects.

Although the problem of deviations in projects is global, the different studies carried out conclude that the level of development of the country, as well as the time frame and its socio-economic context in which the study is carried out, have an impact on the overruns. Thus, generally, a lower degree of cost overruns is observed in more developed countries, due to the implementation of control and monitoring systems [5], even in developing countries [6].

In order to reduce the project cost overruns, it is necessary to do better and more detailed projects with more previous studies, so no modifications or complementary projects are needed. However, this supposes a much higher investment in research and design phases (which still lower costs than the adaptation of the project during the construction phase) [7] that the promoters do not want to assume.

Other authors like Cheng [8], have focused their research on project cost overruns sources. He has defined 16 key factors which cause the overruns, developing a method to control them. He finally concludes that in order to minimize uncertainties and reduce cost overruns, companies must thoroughly understand all customer needs in the following way: fulfilling a good communication with the client; determinate and understand perfectly the scope and specifications of the project; applying different cost control measures by contractors during project execution; before the project begins, the construction companies should carry out an in-depth investigation in order to adapt the characteristics of the project to the client and vice versa, this would minimize uncertainties and reduce the possibility of cost overruns.

On the other hand, Kaming et al. [9] establishes the higher costs and incorrect estimates of the materials, as the complexity of the project, to be the main reasons for cost overruns.

Technical constrains, caused mainly by imperfect calculations, lack of data or experience have also been investigated by other authors [7], [10], [11], as well as not fulfilled promises by Public Administrations or politicians [3], [12], [13], [14], [15], for causing cost overruns.

One of the most cited authors on project cost control, Flyvbjerg [16], conclude with this study highlighting five points of good and bad practices that help to understand and stop the excess of cost overruns. Recognizing that the main cause of cost overruns is human bias, which causes the scope to change throughout the planning and delivery of the project, generating the feared cost overruns. To eliminate it they use reference class forecasting (RCF) that build on behavioral science [17].

By contrast, in response to the previous cited research, Ahiaga-Dagbui et. al [18], argues the RFC are not actually helpful to identify, mitigate, prevent and quantify the main risk that may affect

the infrastructure project in question, since among other it adopts a simplistic perspective that does not consider other proven causes of project cost overruns apart from bias, which have been tested and validated in many other research studies. RFC has no relevant data to answer the question of why projects perform poorly on capital expenditures, so it does not generate learning for the next project.

Project cost overruns quantification has been always a hard field of research due to the difficulty of calculate the exact finally budget of a project considering all its modifications and deviations. These modifications from the original project, even talking about Public Administrations, are not that easy to find and collect, since data sharing and publication vias have not been very transparent and efficient. However, there have been made several studies about this topic, and more recently, Open Data awareness has been increasing, so this problematic may change in years to come.

Flyvbjerg et. al [19] compiled a database of 258 transport infrastructure projects from 20 countries on the five continents finished between 1927 and 1998. 86% of the projects incurred on cost overruns, with an average of 28% deviation. Rail projects overruns were higher (45%) than road construction ones (20%). Projects which have more complexity, as they include bridges and tunnels, their average cost overrun of 34%, with 48% for tunnels and 30% for bridges. Project from Europe have recorded lower overruns than North America or other areas.

In Holland, after analyzing 78 road and railway projects developed in that country between 1984 and 2010 [5], they conclude that in 55% of the projects have cost overruns and the average is 16.5%.

After a study of 35 transport infrastructure projects completed between 1983 and 2010 in Asia, Young-Il and Theopisti C. Papadopoulou [20], set the average cost overrun at 28%, higher in short- and long-term projects than in medium-term projects.

Also in Asia, based of data from, 267 transport infrastructure projects executed between 1992 and 2008 [6], it is found that 51% of projects have cost overruns and that these are, on average, 84% of the initial budget in the case of railway projects and 8% in the case of road projects.

In India from a study carried out by Ram [21] between 1992 and 2009, of a total of 894 infrastructure projects, 41% had additional costs, with an average value of 15%. of these projects 157 were transport projects with costs overruns in 54% of the cases with a value of 16%.

A report by Grattan Institute [22] researchers the results of the costs of 836 projects from 2001 to 2015, valued at more than 18 million euros. In this study 17% of the projects exceed by more than a half the planned cost. Thanks to this relatively low percentage, 90% of project cost overruns in Australia can be explained.

More recently, a study carried out by [1] analyzed data from 1091 public transport projects developed between 1980 and 2012 in Portugal, in which the percentage of deviation from the average cost was 17.8%, with minimum and maximum cost deviation percentages of -79.5% and 136.9%.

Using a set of data belonging to transport works of the public sector of Hong Kong with an estimated cost of 13.12 billion euros [2], showed that 47% of projects were out of their approved budget.

It then becomes clear that the problem of cost overruns is global and that their magnitude is, in most cases, contradictory to the efficiency measures that most governments enact.

3. Cost Overruns in Spanish Civil Engineering Projects

In the case of Spain, contractor companies have based their business benefits on a trust-based relationship with the Public Administration. This implied the assumption that the awards would have a certain level of distribution among all the companies of the sector. In addition, it was a common practice for the awarded companies to seek to increase the budget offered up to the legal limit, with general cost overruns of around 10%, as well as modifications up other 10%, as stipulated in previous Public Procurement Law.

In order to adapt national regulation to European legislation, the previous regulation has been reformed giving rise to the new law on contracts that came into force on 9 March 2018 [23]. This new law allows for modifications of up to 15% of the total without lack of justification, previously could generate cost overruns of 10% always followed by justification to the hiring administration, even if there was no control at all suspicious cases. In addition, in this new regulation, the increase in the limit for modification works during the execution period agreed with the administration rises from 10% to 50% of the initial price.

Usually, these cost overruns (or very close percentages) have been granted, since the bidding-low the contractor company made to the bidding, already contemplates these cost overruns within the real planned budget of the company.

In addition, it would not be very complicated in the situation of economic problems during the course of the works, the attainment of a complementary project or an emergency works project, which would substantially increase the award budget. For this reason, companies no longer needed an exhaustive study of the costs of the work units, since the final benefit depended fundamentally on the relations with the Public Administration [24].

After analyzing the modifications of public works projects developed by the Spanish Ministry of Public Works before 1994 [25], the causes of cost overruns are established according to Table 1, ordered according to the percentage of cases in which they occur are:

TABLE I. Cost Overruns Causes in Public Works Projects [25]

Causes of cost overruns	Number of cases
Project design errors correction	43%
Project improvements from original idea	20%
External request changes	12%
Changes forced by the public administration	10%
Regularization of emergencies and accidents	6%
Regulatory changes	5%
Other causes not defined	3%
Changes requested by other actors	1%

From this it can be deduced that in 63% of the cases the cost overruns are associated with a deficient project or that requires improvements in order to be put into operation [26] due to several factors such as: modification of project work units using existing prices in the contract; inclusion of units not covered by the contract; alterations caused by different conditions from the considered in the design phases, which lead to constructions difficulties; quantitative modifications or addition of project units; definition of new accessory or complementary works; failed estimations

of project items during early phases; project scope modifications due to the time-gap between design and construction phases; outdated prices database used to prepare de project budget.

Finally, talking about cost overruns quantification in Spain, the only study carried out in this area [25], analyses the modifications in public works of more than 3 million euros carried out by the Ministry of Public Works before 1994, concluding that 77% of the projects had an additional cost that represented an average of 14% of the tender price. An analysis of their distribution shows that more than a third of the works had a cost overrun between 19 and 20%.

4. Conclusions and Future Research

Project cost overruns has always been a very interesting field in project management in general, and in infrastructure and civil engineering projects in particular. This is because most of these projects are financed with public money, which makes society to be interested in an efficient and responsible use of resources, without cost overruns.

However, it has been systematically observed that most of the infrastructure projects have registered very significant cost overruns. This situation goes totally against the path towards a sustainable development society, in which resources should be used as efficiently as possible. Therefore, many authors have investigated its causes and its quantification.

Most of the cost overruns in construction projects are related to important changes in the initial design of the project, due to the adaptation of outdated projects or due to a quality deficit in the engineering phase. Investing more resources on early stages of the project and design phases, would lead to better and more defined projects where there would be less modifications, and problematic situations with prevented actions planned.

Despite of cost overruns is a global problematic; several authors established a relationship where more developed countries show lower overruns. In most of the research, more than a half of the projects studied registered a cost overrun, which vary between 10% and 50%. It is also shown that more complex projects such as railway, tunnels or bridges, recorded higher values.

The cost overruns in Spanish infrastructure projects in recent years, have become an economically unviable problem in a modern and efficient society, with cost overruns amounting to billions of euros over the last decades.

These overruns have been based by the relationship between Public Administrations and contractors, as well as the methodology followed by contractors' companies in order to achieve the maximum amount of cost overrun the current laws enable.

For future research, it is proposed to carry out a study of cost overruns in the case of railway infrastructure construction in Spain, to compare it with the results of this review. In addition, it is also proposed to investigate the methods and agents of the public auction of projects and their relationship with the final deviations of the projects.

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OVERVIEW OF PHD RESEARCH IN CONVERGENT KNOWLEDGE MANAGEMENT IN MULTINATIONAL PROJECTS

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Abstract: *The aim of the research was to develop conceptual provisions, models, methods, and approaches that form the basic principles of convergent knowledge management implemented to multicultural multinational projects for all their participants, as one of the success factors.*

Keywords: knowledge management, convergence, multinational projects, knowledge, information, fuzzy logic, β -convergence

1. Introduction

A model of knowledge transfer in multinational projects considering efficiency factors (factors influencing to knowledge transfer efficiency in multinational projects) has been developed, as a basis for assessing the convergence level of project management systems of different stakeholders. The author's approach to the system of indicators of the project management convergence level formation is proposed and implemented, which unlike to the existing ones considers fuzzy evaluation parameters and allows their forecasting to identify possible problems of participants' interaction at the project initialization stage. The research is aimed at solving these problems and is primarily due to the objective need to increase the efficiency of multinational projects.

The practical implementation of the author's models and methods of convergence of knowledge management systems in multinational projects is presented in the form of a fuzzy knowledge matrix for assessing convergence on indicators that most affect the project. The software developed on this basis, allows us to calculate the ability of the system to converge knowledge. Approbation and implementation of the developed models and methods is implemented and performed within the research work of the Project Management Department of Kyiv National University of Construction and Architecture, as well as in numerous international projects such as "IPMA Research Conference" organization (2016-2018), trainings for assessors for the national award "National Project Excellence Award" in the Azerbaijan Project Management Association and the Kazakhstan Project Management Association, etc.

2. Analysis of Factors and Problems in Knowledge Management in a Multinational Environment

According to the analysis of modern research in the field of knowledge management, the nature of the subject of research determines the complexity of formalization. Variegated study of knowledge management models detected the lack of a unified approach to knowledge management (convergence), as the processes of globalization, which steadily affect the project activity, radically change the usual conditions of its conduct. Under such conditions, the problems of analysis of the multinational projects indicators and creating an effective information space for the exchange and acquisition of new and useful knowledge came to the fore.

Knowledge management systems today are mostly implemented in the form of a social network, which function is convenient dissemination of "best practices", while a lack of attention given to the knowledge management. Moreover, additional difficulties arise due to cultural, linguistic, general, technical, etc. features of the participating countries. The necessity of knowledge management helps to reduce the information asymmetry in teams participating in multinational projects.

Successful knowledge management in multinational projects requires the creation of a new convergent model of knowledge management, the novelty and originality of which determines changes in the structure of basic and applied research related to the development of knowledge management, as well as new approaches to managing the community of professionals involved in multinational projects.

Based on described research key Knowledge transfer efficiency factors in Multinational projects were defined (Fig. 1).

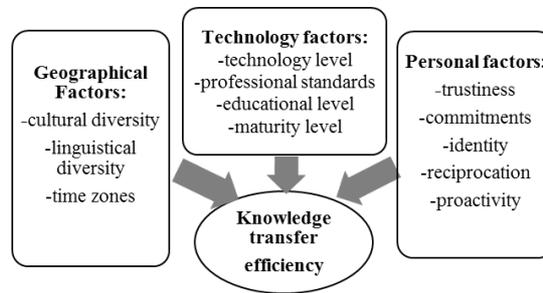


Fig. 1. Knowledge transfer efficiency factors in Multinational projects [1]

3. Analytical Principles of Research of Convergent Knowledge Management in Multinational Projects

The definition of the concept of convergence in multinational projects is given based on which the internal and external convergence are distinguished. This distribution allows us to separate approaches to their definition and to the formation of convergence management methods in multinational projects. [2]

A method for determining the level of external convergence of a multinational project and a scale that characterizes the possibility and feasibility of using the project as a reference for decision-making in a new (current) project, based on existing experience is suggested.

An integrated indicator is formed to determine the internal convergence of the project using the criteria of fuzzy logic in multidimensional space. To formalize the functional criteria for estimating the level of convergence, it is proposed to use the apparatus of linguistic variables. The novelty of this approach is in the synthesis of fuzzy set theory and experimental planning theory [3,4]. Functional criteria for assessing the level of convergence in multinational projects (eg, knowledge and experience of experts) are formalized as a polynomial, and a set of production rules based on functional criteria at a certain point in the factor space, bearing implicit form, is formed as an orthogonal matrix.

Models for the formation of a system of indicators of the convergence level by determining the integrated indicator and β -convergence, using models of "regression of growth to its initial level" (growth-initial level regressions), in which the dependent variable is the growth rate and independent - the initial level (system convergence level) is suggested.

The method of estimating the level of convergence of multinational projects is determined, which considers fuzzy evaluation parameters, and allows to perform their forecasting to determine possible problems of interaction of participants already at the stage of project initialization.

The criteria for assessing the level of convergence of a multinational project are defined, which are grouped into three groups: project, contextual and geographical.

The method of assessing convergence in multinational projects in the following stages is presented below (it should be noted that the assessment can be carried out regardless of the subject area of the project). An algorithm for constructing a model for estimating the level of convergence in multinational projects with the formalization of functional criteria in a multidimensional space is proposed. In general, it is carried out in several steps presented (Fig. 2):

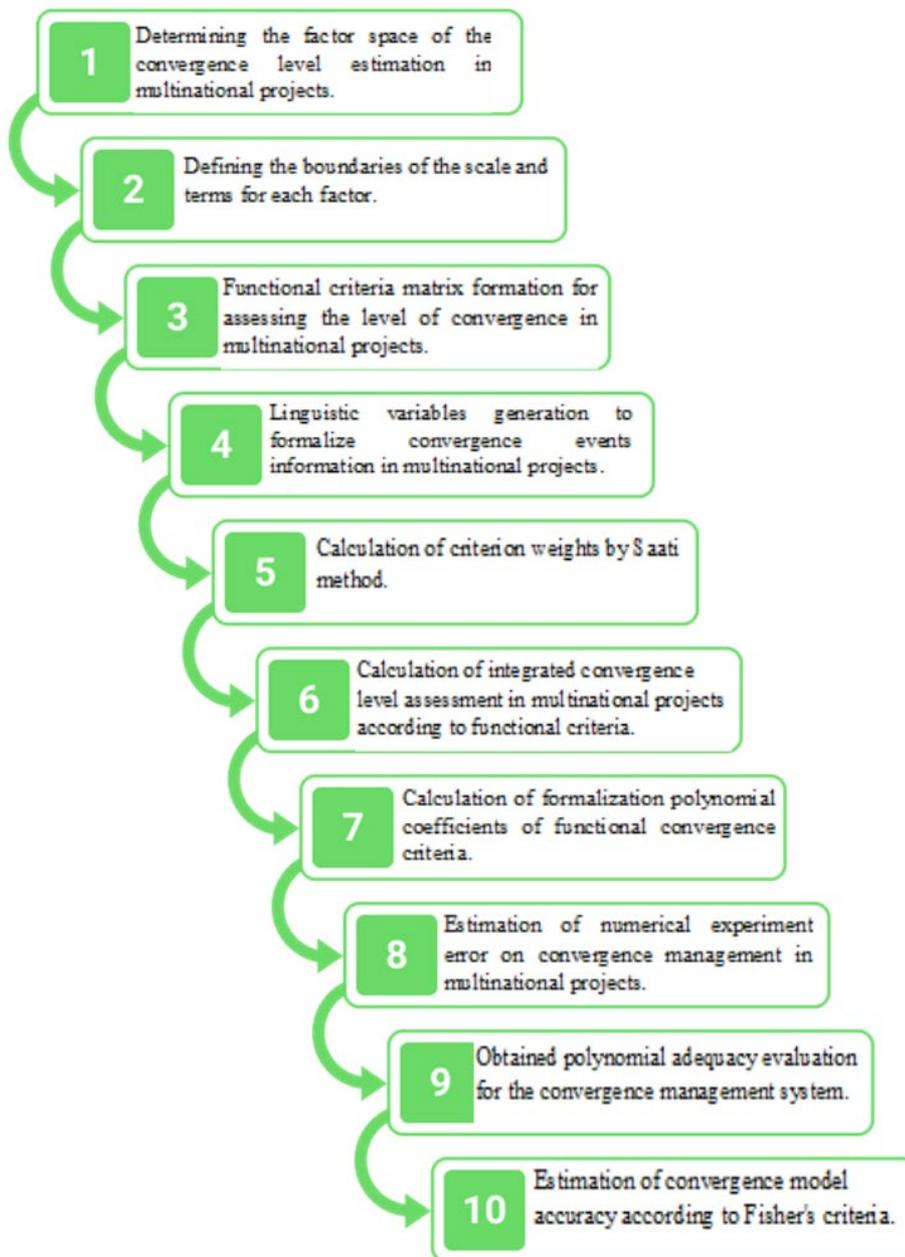


Fig. 2. Conceptual research model

A linguistic assessment of these criteria has been carried out, which can be used to collect input data when modelling the convergence assessment system of a multinational project.

TABLE I. Linguistic Assessment of Convergence Criteria in Multinational Projects
(fragment with project group of criteria only)

Variable	Weight, w	Name of the metric (criteria) Terms of linguistic variables of the model	Terms of linguistic variables of the model
Convergence of project factors (Z1) (0.6) Different (D), Close (C), Similar (S)			
y_1	0,3	Level of project management (PM) standardization	Low (L), Medium (M), High (H)
x_1	0,5	Procedures coverage completeness by standardization process	Standardized separate PM processes (L); All PM processes are standardized (M); Developed a procedure for continuous improvement of PM processes (H)
x_2	0,2	Distribution of project quality management functions	Quality management functions are distributed among project participants (L); Quality management functions are assigned to an individual project participant (M); Developed and implemented project quality management plan (H)
x_3	0,3	Use of quality management methods	The quality of the project is determined by deviations from the planned (L); Project quality is planned and formalized (M); In addition to quality planning, its constant assessment and forecasting (methods of mastered volume, etc.) is carried out (H).
y_2	0,2	The level of standardization of the subject area	Low (L), Medium (M), High (H)
x_4	0,3	Complete coverage of project product by standards	Product quality is determined by organizational (corporate) standards (higher discrepancy) (L); Product quality is determined by state standards (M); Product quality is determined by international standards (H)
x_5	0,2	Standardization of processes (technologies) of product development	Separate processes of product development are standardized (L); All product development processes and technologies are standardized (M); A procedure for continuous improvement of product development processes is developed (H)
x_6	0,5	Standardization of development process management	Standardized product development planning processes (L); All processes of planning, organization of product development and quality control (M) are standardized; A procedure for continuous improvement of product quality management processes is developed (H)
y_3	0,3	Level of PM methodologies implementation	Low (L), Medium (M), High (H)
x_7	0,4	Use of flexible methodologies	Partial use of some tools (L); Use of methodology tools and principles (M); Full formalized implementation of methodology (H)

Variable	Weight, w	Name of the metric (criteria) Terms of linguistic variables of the model	Terms of linguistic variables of the model
x_8	0,2	Use of Waterfall methodologies	Partial use of some tools (L); Use of methodology tools and principles (M); Full formalized implementation of methodology (H)
x_9	0,4	Use of mixed (blended) methodologies	Partial use of some tools (L); Use of methodology tools and principles (M); Full formalized implementation of methodology (H)
y_4	0,1	The level of implementation of PM information technologies	Low (L), Medium (M), High (H)
x_{10}	0,5	Completeness of PM information technology functions	Use of tracking systems to track the task performance (L); Use of systems that provide methods of planning and monitoring of project work (M); Integrated, distributed PM systems (H);
x_{11}	0,2	Degree of System protection	Open systems (L); Systems with different degrees of access (M); Closed corporate systems (H)
x_{12}	0,3	Scalability of information systems	For small teams (up to 15 participants) (L); For medium teams (up to 50 participants) (M); For large project teams (more than 100 participants) (H)
y_5	0,1	The level of PM terminology development	Not defined, the general concepts are used (L); Prescribed in the organizational standards (M); Defined by standards at all management levels (H).

To scale the system of convergence indicators of the project, the use of the Method of Hierarchy analysis (MHA) is proposed. Assessing the weight of each of the criteria allows us to optimize the size of the model, considering the specifics of the project, by rejecting indicators with smaller values and enhancing the impact in the model of indicators with the largest values.

The main steps of MHA include:

1. Hierarchical representation of the problem.
2. Construction of a set of matrices of pairwise comparisons.
3. Definition of vectors of local and global priorities.
4. Checking the consistency of the results.
5. Calculation of the general MHA assessment.

Step 1. Usually, the hierarchy is built from the top - the global goal in terms of solving the problem, through the intermediate levels on which the goal depends, to the lowest level, which is usually a list of alternatives. Each of the presented criteria may have several sub-criteria. They in turn can have several levels of sub-criteria. (Note that Table I shows the general hierarchy of criteria for the project group of criteria).

Step 2. In this step, the criteria of multinational projects are evaluated.

Evaluation by quantitative criteria. Score or rating for a criterion that has a positive effect is calculated by normalizing the values per unit.

For criteria that has a negative effect, the relative score is calculated by determining the inverse values and their subsequent normalization.

Evaluation by a qualitative criterion is based on determining the predominance of factors of the PM system, using the scale of relative importance of objects according to Saati (Table II).

Consider a finite set of criteria $X = \{x^1, \dots, x^m\}$ (1). Based on the results of the research, we will compile a matrix of pairwise comparisons $A = \|a_{ij}\|_{(m \times m)}$ (2).

TABLE II. Saati Scale of Relative Importance of Objects

Definition	Degree of importance
factors of PM systems are equivalent	1
PM factor of one participant slightly outweighs the factor of another	3
one factor of the PM system outweighs the other	5, 7, 9
intermediate judgments about the factors of the PM system	2, 4, 6, 8

When compiling matrices of pairwise comparisons, expert judgments should not violate axioms, i.e. if the answers of decision-makers were consistent with each other, then:

$$a_{ij} = \frac{w_i}{w_j} \quad (3), \quad \forall i, j = \overline{1, m} \quad (4);$$

if, $a_{ij}=1, a_{ij}=\frac{1}{a_{ji}}$ (5) $\forall i, j = \overline{1, m}$ i.e. (6), if $x^i \succ x^j$ in $\alpha > 1$, than the value of the factor of

the PM system x^j is $\frac{1}{\alpha}$ the value of the factor of the PM system x^i ;

$$A = \begin{pmatrix} w_1 \\ \dots \\ w_m \end{pmatrix} = m \cdot \begin{pmatrix} w_1 \\ \dots \\ w_m \end{pmatrix} \quad (7) \text{ full consistency.}$$

This means that the vector of relative values $(w_1, \dots, w_m)^T$ is the eigenvector of the A matrix and corresponds to the eigenvalue $\lambda = m$ of this matrix.

After the construction of the A matrix, the relative values of the factors of the PM system are searched, for which $\lambda_{\max} \rightarrow m$ (where m is the largest eigenvalue of the A matrix). The closer $\lambda_{\max} \rightarrow m$, the better coordinated the answers of the expert.

Step 3. The calculation of the vector of the relative value of the factor of the PM system is performed using the geometric mean of the elements of each of the rows of the A matrix:

$$w_i = \frac{\sqrt[m]{a_{i1} \dots a_{im}}}{\sum_{i=1}^m \sqrt[m]{a_{i1} \dots a_{im}}}, \quad i = \overline{1, m} \quad (8)$$

Let us estimate the value of the eigenvalue, which corresponds to the calculated vector of relative values. To do this, we will find the product: $A \cdot w$.

To estimate the value λ_{\max} , we divide component of $A \cdot w$ product to the components of the vector of relative values w . For the approximate value we choose the arithmetic mean component of this vector. Note that the sub-criteria have both local and global priority.

Step 4. Matrices of pairwise comparisons based on subjective judgments and may be inconsistent. To assess the degree of deviation from consistency, the so-called consistency index (CI) is used: the values of which are compared with the reference (Table III.). If so, the results of the expert survey are satisfactory.

TABLE III. Reference Values of the Consistency Indicator, depending on the Number of Criteria Being Compared

Number of criteria	3	4	5	6	7	8	9	10	11	12	13	14	15
J_e	0,58	0,9	1,12	1,24	1,32	1,41	1,45	1,49	1,51	1,54	1,56	1,57	1,59

Step 5. The use of pairwise comparisons in MAI makes it possible to correctly determine the weights of indicators and rank them only if the consistency index (CI) does not exceed 10%. In the case of analysis of factors that have heterogeneous numerical characteristics, the problem of consistency of comparisons is somewhat reduced and largely depends on expert assessments when comparing non-parametric criteria. In such cases, it may happen that the obtained vectors of relative values of alternatives or vectors of weights (both the criteria in the indicators and the indicators themselves) may have a significant degree of inconsistency compared to the ideal experiment.

To study the level of convergence, we first compile a matrix of pairwise comparisons of the components of the three-dimensional vector z (z_1, z_2, z_3) of the system for estimating the level of convergence. We use the MS Excel software package to solve this task. The results obtained are listed in table IV.

By analogy, we compile matrices of pairwise comparisons for each group of factors influencing the level of convergence.

As a result of applying the MHA, it is possible to scale the system, highlighting the influence of significant factors and discarding insignificant factors to build a fuzzy system for assessing the level of convergence in multinational projects.

TABLE IV. Matrix of Pairwise Comparisons of Project, Context and Geographical Metrics of the System for Assessing the Level of Convergence in Multinational Projects

	z_1	z_2	z_3	w_j
z_1 - project	1	3	5	0,62
z_2 - context	0,(3)	1	4	0,28
z_3 - geographical	0,2	0,25	1	0,09
Convergence %	7,39			

An example of a model of a scalable system of convergence indicators of a project is given, which confirms the feasibility of such an approach for further modelling of a fuzzy system for assessing the convergence of a project.

To build a fuzzy system for assessing convergence in multinational projects, knowledge matrices have also been formed, which reflect the knowledge base in the form of rules. The model includes

additional initial values that determine the measures to manage convergence depending on the values of the input parameters of a particular subsystem.

It is proposed to use known regression models to predict convergence indicators. Assessment of the adequacy (or compliance) of the regression model of convergence indicators with the observed data is based on the analysis of residues. Fisher's F-criteria is used to determine the accuracy of the regression model of convergence management.

Identified types of support system's potential for innovation-oriented interaction contains recommended project development strategies depending on the obtained indicators of project convergence at different levels: project, contextual, geographical, which allows to make management decisions at different stages of project implementation.

Testing of presented models and tools were implemented in multinational teams, with representatives of such countries as Netherlands, Germany, Poland, England, France, Italy, Russia, Ukraine, Azerbaijan, Iceland, Korea, Brazil. In such a rank, the composition of the teams is prompted by the concept of "multiculturalism", such as the team is represented by more than two cultures. The teams included the target groups and members of the project teams:

- Project managers and members of international projects teams;
- Consultants in project management;
- Scientists in project management (Doctors of Science, Doctorate, Postgraduate studies);
- Representatives of national associations for project management, member associations of IPMA (Germany, Netherlands, Poland, England, Japan, India, Russia, Azerbaijan, Iceland, Korea, Brazil);
- Master's degree program students in "Project management" of the Faculty of Automation and Information Technologies of the Kiev National University of Construction and Architecture.

The practical implementation of the author's models and methods of convergence of knowledge management systems in multinational projects is presented in the form of a fuzzy knowledge matrix for assessing convergence on indicators that most affect the project. The software developed on this basis, allows us to calculate the ability of the system to converge knowledge. Approbation and implementation of the developed models and methods is implemented and performed within the research work of the Project Management Department of Kyiv National University of Construction and Architecture, as well as in numerous international projects such as "IPMA Research Conference" organization (2016-2018), trainings for assessors for the national award "National Project Excellence Award" in the Azerbaijan Project Management Association and the Kazakhstan Project Management Association, etc.

4. CBR (Case-Based Reasoning) Methods Implementation to Successful Knowledge Transfer in Multinational Projects

The definition of knowledge transfer in the field of multinational project management is formed, as well as the concept of knowledge transfer capacity is proposed. These definitions reveal the features of the processes of knowledge transfer and storage in multinational projects and form the basis for building a model of knowledge transfer.

The developed model of knowledge transfer in multinational projects contains stages of knowledge transfer and is based on the well-known CBR approach to knowledge management. The possibility and expediency of using such an approach are substantiated, as well as the problems of its implementation in knowledge management in multinational projects are highlighted. The conditions for the implementation of the proposed model are defined, which to

some extent limit its use in projects, but their consideration at the beginning of the project increases accuracy of the obtained results [5].

The workflow of the CBR approach is defined, based on Kolonder's work [6], adapted for use in multinational projects and can be used to solve project problems based on analysis of previous experience, by selecting similar solutions in certain clusters of projects similar to the current project.

The advantages and disadvantages of the CBR approach implementation in knowledge management in multinational projects are identified. The advantage of the method is the self-learning of the system, which refers it to artificial intelligence systems, and research in this area in the field of project management is currently at an early stage. Also, the use of the approach does not require very complex formalization, which greatly facilitates the collection of data to form a database of cases from homogeneous projects. The disadvantages include the technical complexity of the software implementation of this approach, as the design and creation of information systems to support it requires sufficiently deep skills in designing knowledge bases and search engines. This, of course, causes the high cost of such systems and the long duration of their implementation. Thus, the creation of an information system to support the CBR approach can occur through the implementation of a joint project of multinational companies interested in its actual application.

5. Testing Results of the Study

The Fuzzy Logic Designer package of the Matlab computing environment was used to assess the level of convergence of a multinational project based on the method proposed in the paper for constructing a fuzzy system.

The assessment of the level of convergence of a multinational project is carried out in the form of a dialogue. Entering inputs occurred by sequentially entering the appropriate number of one of the proposed response options through the command window (Command Window) in Matlab.

Based on the implemented model, intermediate values of the initial data of individual subsystems of project indicators are proposed, which contain recommendations for convergence management for these indicators. They are described in terms of support, development, and integration, and determine the state of the knowledge system in a multinational project.

Based on the model, the assessment of the convergence of three international projects, which can be attributed to one cluster, as they are similar in terms of implementation, number, and composition of participants, as well as scale, showed that the second project was the most capable of convergence. In the initiation and planning phases, the project lagged behind, but then, due to the introduction of a single project management standard (PMBok) [7] to all participants, it was possible to significantly improve the interaction in the project and achieve its successful implementation. Data on the other two projects were also analysed (Fig. 3).

Within the framework of the method proposed in the work, the similarity of the new project to those implemented in terms of convergence (through the Euclidean distance) was determined, which allowed to predict the emergence of similar problems in the new project and to propose measures to prevent them.

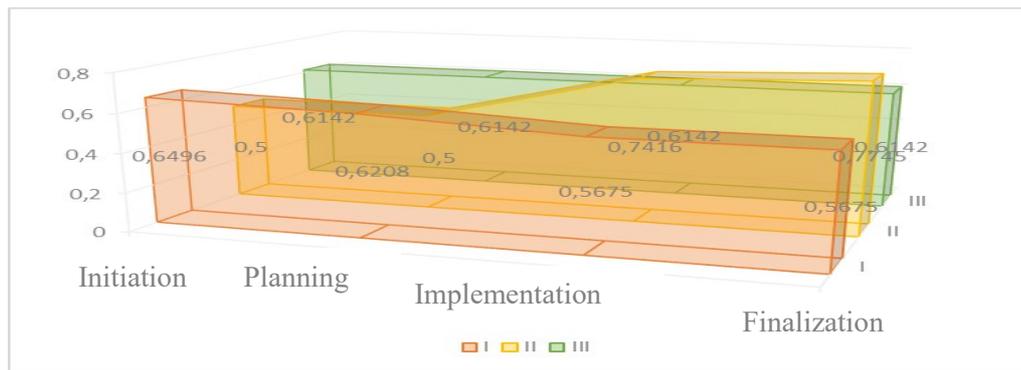


Fig. 3. Schedule of convergence of projects by phases

The practical implementation of the methods of forecasting and estimating the accuracy of the convergence model presented as the example of the project "Organization of the international scientific-practical conference PM Kiev 2021". The obtained value indicates that despite the rather low initial level of convergence of the executor of the project "Organization of the international scientific-practical conference PM Kiev 2021" in the initial period on average there were quite high growth rates. The constructed regression model allowed to predict the value of convergence at the level of 0.63, which corresponds to a high level of convergence. The accuracy of the regression control model was evaluated according to Fisher's test, which showed the significance of the model.

6. Results and Conclusion

In the dissertation research, an urgent and important problem of determining the level of convergence of management systems in multinational projects in the form of an integral indicator (aggregated parameter) using the apparatus of fuzzy initial information (uncertain parameters of the dependences of the indicators of input and output variables) is solved, which ensures an integrated approach during project decision making.

As a result of the set problematic scientific tasks solving, the following main theoretical and practical results were obtained:

1. The analysis of existing methods of convergent knowledge management in project management is carried out. The analysis allowed the author to form a problematic field of research.
2. The factor space of the problem of estimating the level of convergence in multinational projects is defined. Factor space fully takes into account the specifics of multinational projects.
3. Conceptual model of researches which includes ten consecutive steps is constructed;
4. Matrices of functional criteria for assessing the level of convergence in multinational projects have been proposed, which made it possible to evaluate solutions for the knowledge convergence.
5. Linguistic variables have been determined to formalize information about convergence events in multinational projects. Such variables made it possible to build models and a method for fuzzy assessment of the knowledge convergence in projects.
6. The calculation of the integrated estimation of convergence level estimation in multinational projects on functional criteria and determination of polynomial coefficients of formalization of functional convergence criteria is made. The calculation showed the adequacy of the proposed models and methods.

7. The limits of the factor space of the problem of the convergence level assessment in multinational projects and the scale of terms for each factor are determined. The errors of numerous experiments on convergence management in multinational projects are estimated and the adequacy of the obtained model (polynomial) for convergence management is estimated.
8. A model of using the CBR (Case Based Reasoning) approach to preserve knowledge based on convergence is constructed. The model allows to form effective methods of data processing and storage.

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