Lecture Notes on Multidisciplinary Industrial Engineering
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Proceedings on 18th International Conference on Industrial Systems – IS'20

Industrial Innovation in Digital Age

Springer

Lecture Notes on Multidisciplinary Industrial Engineering

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Industrial Innovation in Digital Age

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ISSN 2522-5022 ISSN 2522-5030 (electronic)
Lecture Notes on Multidisciplinary Industrial Engineering
ISBN 978-3-030-97946-1 ISBN 978-3-030-97947-8 (eBook)
https://doi.org/10.1007/978-3-030-97947-8

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

Preface

The Department of Industrial Engineering and Management at the Faculty of Technical Sciences in Novi Sad organizes a Scientific Conference on Industrial Systems once in three years, with the following goals:

- to bring together prominent researchers and practitioners from faculties, scientific institutes, and different enterprises or other organizations,
- to enable presentation of new knowledge and exchange of practical experience in industrial systems engineering and management and
- to propose theoretically developed and practically tested solutions for manufacturing and business improvements achieved in the period between two conferences.

This was the 18th International Scientific Conference on Industrial Systems entitled Industrial Innovation in Digital Age hosted by the University of Novi Sad—Faculty of Technical Sciences—Department of Industrial Engineering and Management, from 7 to 9 October 2020. Conference covered different topics from the fields of industrial engineering, engineering management, information and communication systems, mechatronics, robotics and automation, quality, effectiveness, and logistics with over 100 submissions sent in. The scientific committee accepted 88 contributions of authors from different countries all over the world of which the final selection of the proceedings included 84 top-quality papers. All papers were reviewed by at least two members of the scientific committee, composed of renowned scientists specialized on the specific topics, whose work is deeply appreciated.

During the conference, two keynote speakers held very interesting and valuable lectures: Professor Iztok Palčič from the University of Maribor, Slovenia—"Industry 4.0 Readiness Index" and Professor Feng Gengzhong from Xi'an Jiaotong University, China—"Future of management science and industrial engineering".

Because of the COVID-19 pandemic, this conference was held in combined mode—live and via the Cisco Webex platform, divided in 14 different sessions. Despite these new circumstances, the conference was very successful and very constructive, useful discussions were conducted at each session, and they were

mostly focused on the changes caused by the pandemic, as well as on predicting the directions after the pandemic.

February 2021

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Contents

Quality Management and Innovation Performance: A Short Literature Review

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Abstract. The purpose of this study is to examine the relationship, and its nature, between quality management and innovation performance. Needless to say, quality management and innovation have the same purpose in the organization; they both provide continual improvement and sustainable development. A literature review was done, discussing the relationship between these two organizational aspects. The results suggest that the academic community is divided, concerning the positive nature of this relationship. However, the results of this study speak in favor of the positive findings, providing empirical evidence in supporting fostering power of quality management towards the development of innovation performance.

Keywords: Quality management · Innovation · Innovation performance

1 Introduction

In today's competitive marketplace, organizations must effectively manage innovation performance to achieve positive results and ensure a competitive position [1–3]. To successfully achieve the goal, organizations should change their culture and have organizational support at the strategic level [4]. Many researchers consider quality management in the organization provides a suitable environment and conditions that lead to generating distinctive capabilities in different aspects of the organization, to employees be more flexible in responding to the changes in the environment, and develop process and product innovation [5–7].

However, some researchers advocate a positive link between quality management and innovation performance [7–12]. Others, instead, emphasize quality management does not reach the expected results [13–15]. Thus, the issue of quality management supporting an adequate environment and innovation culture remains conflicting. The main goal of this study is to examine the relationship between quality management and innovation performance. Also, the factors with a mediating influence between quality management and innovation performance are identified.

A review of the literature based on Scopus shows that there is a lack of empirical studies conducted in the Republic of Serbia. Thus, our next goal is to explore constructs of quality management and innovation performance, and possible mediators, as a basis for future empirical research.

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 1–8, 2022.
http://doi.org/10.1007/978-3-030-97947-8_1

2 Research Methodology

The research methodology in this paper builds upon a Systematic literature review (SLR). Firstly, the research questions were defined according to previously mentioned theoretical assumptions. These are:

- RQ1: "What is the impact of quality management on innovation performance?"
- RQ2: "What elements emerge as mediators in the relationship between quality management and innovation performance?"

After that, we defined research keywords by research questions. The keywords were defined as follows:

"QUALITY MANAGEMENT" OR "QUALITY MANAGEMENT SYSTEM" OR "*QM" OR "TOTAL QUALITY MANAGEMENT" OR "ISO 9001" AND "INNOVATION PERFORMANCE."

These keywords were used to define search queries within the SCOPUS indexed database. The query has returned 83 papers (Fig. 1).

In order to achieve more accurate results, the search query was redefined. The first phase of the search was performed on titles, abstracts, and keywords to the above-mentioned "inclusion criteria" (Table 1). The redefinition of search results has re-turned 52 papers in total.

Papers were then assessed by their title, abstract, and their content. Some papers were not related to the scope of review. Thus, we removed them from further analysis.

Table 1. Inclusion and exclusion criteria

I/E criteria	Sub-criteria	Criteria explanation
Inclusion criteria	Full-text papers (FTP)	Selected studies that are only abstracts, presentations or posters will not be included in the study
	Language (LAN)	Full text of the article must be written in English
	Time frame (TF)	Selected studies must be published between 2010–2020 to be included in the literature review
	Selected studies (SS)	Studies included journal articles, conference papers
	Subject area (SA)	"Engineering", "Business, Management and Accounting", "Decision Sciences", "Social Sciences"
Exclusion criteria	Non-related (NR)	NR1: Paper is not related to manufacturing organizations
		NR2: Paper is not based on empirical studies

(i.e. "Non-related criteria" - Table 1) Finally, based on NR exclusion criteria (Table 1), out of 52, there were 30 papers retained.

In the second phase, we removed six more papers. The reason that papers were excluded from the further analysis is that they were not technically available through portals and index databases, as well as accessible for downloads. Overall, 24 papers were subdued for detailed analysis.

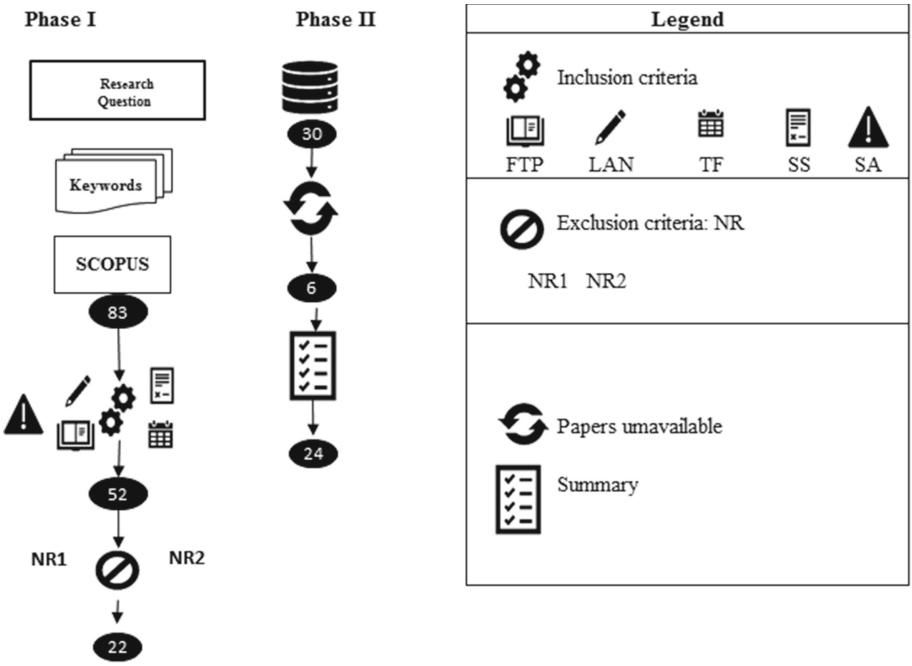

Fig. 1. Flowchart of SLR

3 Results

The results of the literature review are presented in this section. The papers are from academic journals, and all 24 are based on empirical research. In our results (Table 1) only empirical research is included.

The papers are mostly from 2017 (25%) and 2019 (17%), while, there are slightly less papers from 2014, 2015 and 2018 (13%). Only 8% are from 2010 and 2016, while 4% of the papers are from 2011, 2012, 2020.

The research originates mainly from Asia (54%), Europe (33%) and America (13%). It was conducted in the manufacturing industry. Most of the papers from Asia are from Malasia and India. In Europe, most of the studies are from Spain and Greece, and none from Serbia.

The results concerning the constitutional factors of quality management and innovation performance are presented in Table 2 and Table 3. In Table 4 one of the mediators between quality management and innovation performance – knowledge management is presented.

Table 2. Constructs for quality management

Constructs	Literature
Leadership – 11*	Kafetzopoulos, D. et al. (2019), Zhou, F. et al. (2019), Anu P. Anil et al. (2019), Escrig-Tena, A.B. et al. (2018), Yusr, M.M. et al. (2017), Long, C.S. et al. (2015), D., Gotzamani, K. et al. (2015), Yusr, M.M. et al. (2014), Ooi, K.-B. et al. (2012), Hung, R.Y.Y. et al. (2011), Hung, R.Y.Y. et al. (2010)
Employee management – 10*	Kafetzopoulos, D. et al. (2019), Escrig-Tena, A.B. et al. (2018), Yusr, M.M. et al. (2017), Zeng, J. et al. (2017), Zeng, J. et al. (2015), Long, C.S. et al. (2015), Gotzamani, K. et al. (2015), Yusr, M.M. et al. (2014), Ooi, K.-B. et al. (2012), Hung, Y.R. et al. (2010)
Customer focus – 9*	Zhou, F. et al. (2019), Escrig-Tena, A.B. et al. (2018), Yusr, M.M. et al. (2017), Long, C.S. et al. (2015), Gotzamani, K. et al. (2015), Yusr, M.M. et al. (2014), Ooi, K.-B. et al. (2012), Hung, R.Y.Y. et al. (2011), Hung, R.Y.Y. et al. (2010)
Process management – 8*	Zhou, F. et al. (2019), Escrig-Tena, A.B. et al. (2018), Zeng, J. et al. (2017), Yusr, M.M. et al. (2017), Zeng, J. et al. (2015), Long, C.S. et al. (2015), Gotzamani, K. et al. (2015), Yusr, M.M. et al. (2014)
Quality planning – 5*	Escrig-Tena, A.B. et al. (2018), Zeng, J. et al. (2017), Zeng, J. et al. (2015), Gotzamani, K. et al. (2015), Yusr, M.M. et al. (2014)
Learning – 3*	Anu P. Anil et al. (2019), Escrig-Tena, A.B. et al. (2018), Zeng, J. et al. (2017), Zeng, J. et al. (2015),
Supplier management – 2*	Escrig-Tena, A.B. et al. (2018), Yusr, M.M. et al. (2017)
Information and analysis – 3*	Zhou, F. et al. (2019), Gotzamani, K. et al. (2015), Ooi, K.-B. et al. (2012)
Continuous improvement – 3*	Anu P. Anil et al. (2019), Hung, R.Y.Y. et al. (2011), Hung, R.Y.Y. et al. (2010)

* - number of papers.

For data processing, the researchers used SEM (Structural Equation Modeling), in most cases. By synthesizing the literature reviews' empirical results, it was found that quality management does not always have a direct positive impact on innovation performance. For this reason, many papers involve mediators or place particular emphasis on certain factors that contribute to the positive relationship between quality management and innovation performance.

Table 3. Constructs for innovation performance

Constructs	Literature
Product innovation - 8*	Kafetzopoulos, D. et al. (2019), Zhou, F. et al. (2019), Zeng, J. et al. (2017), K., Bin, C.S. et al. (2017), Long, C.S. et al. (2015), D., Gotzamani, K. et al. (2015), Ooi, K.-B. et al. (2012), Hung, R.Y.Y. et al. (2011)
Process Innovation - 8*	Kafetzopoulos, D. et al. (2019), Zhou, F. et al. (2019), K., Bin, C.S. et al. (2017), Long, C.S. et al. (2015), D., Gotzamani, K. et al. (2015), Ooi, K.-B. et al. (2012), Hung, R.Y.Y. et al. (2011), Hung, R.Y.Y. et al. (2010)

* - number of papers.

Table 4. Constructs for knowledge management

Constructs	Literature
Knowledge acquisition – 2*	Yusr, M.M. et al. (2017), Hung, Y.R. et al. (2010)
Knowledge dissemination – 2*	Yusr, M.M. et al. (2017), Hung, Y.R. et al. (2010)
Knowledge application – 2*	Yusr, M.M. et al. (2017), Hung, Y.R. et al. (2010)

* - number of papers.

3.1 Employee Proactive Behaviour and Employee Performance

Leadership should involve employees in all improving process in organizations, and to give them to take the initiative to develop, create, and handle new ideas. Employees work their job every day, and they are the principal source to develop new ideas. Employees have direct contact with clients/costumers and suppliers, and they have all the information from them that could be implemented to develop product or process innovation [7]. Nevertheless, without leadership commitment and ethical human resource management practices, such as training, empowerment, or teamwork and promotion of proactive behavior among employees, innovation development is impossible [16, 17]. Employees should be awarded if they have new ideas and participated in continuous improvement to motivate them [12].

3.2 Knowledge Management

Quality management practices have a positive indirect influence on innovation performance by providing the necessary knowledge. Knowledge management additionally contributes to the positive impact with creation, acquisition, application, and dissemination knowledge between the employees and suppliers, to increase innovative abilities [7, 18, 19]. Knowledge, training, and learning are essential. They change employees' attitudes and perspectives towards any organizational changes that facilitate the successful implementation of process and product innovation [12, 20].

3.3 Organizational Culture and Context

Management commitment, employee involvement, and empowerment, as well as motivation and learning, represent together organizational culture, which supports the development of innovation [21, 22]. Organizational culture should represent leadership who communicate with their employees and involve them in changes [23]. Well - developed human resource management which motivates employees, and organizes training, and in this way elevates the morale and confidence of employees. If employees have the necessary knowledge and skills, the work environment becomes more conducive to work and creation and implementation continuous improvement and innovations [24]. This culture encourages employees to work in a team, which helps promote knowledge creation and sharing, which further stimulates innovation [20].

The proposed research framework is presented in Fig. 2.

Fig. 2. Research framework

4 Conclusion

This research confirms that only through top management practice of quality management, a suitable environment can be established. This way, employees are motivated, and a suitable environment for creating and sharing knowledge is provided, as well as continuous improvement and innovation performance. No improvement within the organization can be efficiently and effectively implemented without the commitment and knowledge of leadership and employees. The dimensions of key factors (Table 2, Table 3, Table 4) have been identified as a basis for future empirical research in Serbia. Furthermore, statistical methods will be established (SEM) in future work, by which the data will be processed. The literature review includes only papers from Scopus, and this is the limitation of the study. Thus, we propose including other index bases through our future research.

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Evolution of a Complex System and Construction of International Ecosystem for Innovation and Entrepreneurship Under the Background of BRI

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Abstract. Confronted with difficulties and challenges throughout the world, humankind is inclined to collaborate due to the limited capability of each. The collaboration is the DNA of homo sapiens, which ensures the sustainable development of humanity.

All human beings, institutions and resources can be considered as the nodes. One node itself cannot develop properly without any interaction with others. The society of human beings is a complex system supported by all the nodes interacting with others. The purpose of interaction and collaboration among all the nodes or the complex systems is to create values for each participant and preserve the public interests. The complex system or super one is growing intensified and its boundary enlarged endlessly due to the constant interactions.

Therefore, the global collaboration in innovation and entrepreneurship is essential to each player's business growth as it gathers all the resources, facilitates technology transfers, and provides access to new markets. Besides, inspired by the Belt and Road Initiative, the institutions from Eurasian countries have co-founded the International Ecosystem for Innovation and Entrepreneurship (IEIE) in the purpose of resourcing, matchmaking and technology transfer. Under the framework of IEIE, neoBay has been devoting itself to the development of IEIE's online platform, and IEIE has so far organized three sessions of online events entitled IEIE | Think Tank, having attracted lots of participants in innovation and entrepreneurship across the globe. It has also proposed its initial operation mechanism. In the future, resourcing, matchmaking and technology transfer among IEIE members will be startup-oriented, realized through digitalization and global networking, and featured by large quantity, flexibility and decentralization.

Keywords: Collaboration · Nodes · Complex system · Folding · Ecosystem · Flexibility · Digitalization · Global networking · Decentralization

1 Introduction

Human history is our collective memory full of challenges, questioning, researching and opportunities. To address the common problems encountered by humanity, homo

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 9–15, 2022.
http://doi.org/10.1007/978-3-030-97947-8_2

sapiens choose to collaborate, finding different ways to eliminate troubles and gain prosperity opportunities. Why are human beings social animals? How can we mobilize the resources on a large scale to create value?

This paper attempts to contribute our answers to these questions through our understanding of collaboration as homo sapiens' DNA, our proposition of complex system to intensify resource accumulation, case study on neoBay Global Innovation and Entrepreneurship Community as well as the construction of IEIE with our international partners under the background of the Belt and Road Initiative.

2 Collaboration, a Core Factor for the Development of Humanity

2.1 Inspiration from the Great Leap Forward Due to the Cognitive Revolution of Homo Sapiens

According to Harari (2015: 3), homo sapiens used to be a kind of species with no significance like other homo species. Despite limited physical performance in competition with other homos (ex: Neanderthals), our ancestors succeeded to survive facing up to all the harsh natural conditions while the others came into extinction. The reason is that "social cooperation is our key for survival and reproduction" (Harari 2015: 26), which was empowered by the Cognitive Revolution.

Consciously or unconsciously, each human being collaborates with others without knowing about others' personalities or backgrounds as the motif for collaboration is initialized by the common idea, ideology, belief, vision, motivation, perspectives or objectives. Motivated by the sharing "story" told and accepted by all, homo sapiens are involved in the flexible mass-cooperation to address all the worldly difficulties, as "imagination was building astounding networks of mass cooperation, unlike any other ever seen on earth" (Harari 2015: 115), which is a great leap forward influencing all the generations of human beings.

2.2 Humankind's Collaboration to Cope with Worldly Difficulties

Human history is made of a series of historical events which mostly represent the worldly difficulties and human beings' struggle to address them. The question is how human beings can cope with all the global challenges even though resources are found limited. The answer is collaboration beyond geographic limit and especially global collaboration to accumulate the resources that allow for handling a specific challenge and solving a concrete problem. By doing that, we can increase the probability of survival, ensuring the sustainable development of an institution and even humanity.

3 Evolution of a Complex System

3.1 Interacting Nodes Inside/Beyond a Complex System and a Super-Complex System

All the resources across a region, a country or the whole world, regardless of their dispersive distribution, are the elementary particles interacting with one and another,

contributing to the continuing increase in complexity at different levels to ensure their sustainable development, which is the fundamental feature of social development. All kinds of complex systems are the networks consisting respectively of many interacting nodes. The interactions between the internal nodes make the complex system as a whole to exhibit certain functions and interact with the outside world through outside nodes. This system can be an enterprise, a social organization or a country. Furthermore, we could take the whole world as a super-complex system composed of numerous interacting complex systems.

3.2 Evolution of a Complex System

The evolution of complex systems can be seen as the process of the interconnection and interaction of nodes in the system, that is, the process of system folding. The process of making the distance between nodes smaller and smaller can be called folding. The folding at all levels is the fundamental driving force for system evolution.

In complex system evolution, the nodes in the system are coupled and coordinated at different levels of material, energy, information, cognition, decision-making and execution, and the whole progress is after a growing pyramid model. As shown in Fig. 1, the collaboration of nodes in the high level system depends on the ability of the collaboration of the lower level. Only when efficient cooperation is formed at all levels can the system evolve into a perfect life system. A life system should be sustainable over some time. As the environment changes, the cooperative relationship between the living system's internal nodes changes, and the self-consistency, self-adaptive ability and flexibility of the system also change.

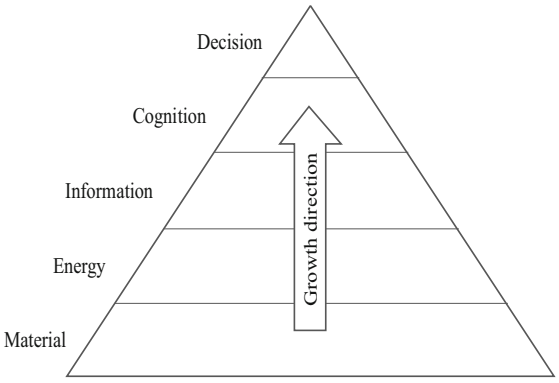

Fig. 1. The pyramid model for the evolution of complex systems

4 Resourcing and Matchmaking Through an Ecosystem for Sustainable Development

Resourcing and matchmaking through an ecosystem are the conventional methods to accumulate the resources for the sustainable growth of startups. In the past five years,

neoBay Global Innovation and Entrepreneurship Community has succeeded to incubate more than 670 startups. More than 470 of them have acquired their business license, Thanks to the close collaboration among three partners, such as Shanghai Jiao Tong University, Shanghai Land Group (an industrial real estate in Shanghai) and People's Government of Minhang District, neoBay has built up an "arrow" connecting academia and industry by offering the resources. The "arrow" is an Incubation/Acceleration process supported by an ecosystem.

neoBay has been devoting itself to accessing the startups to venture capital, which is more than 1 billion RMB. Besides, startups' connection with big multinational corporates is one of neoBay's first concerns. In November 2018, Sodexo, a world leader in Quality of life services, announces that its strategic venture capital vehicle, Sodexo Ventures, has invested in AEYE-GO, a Chinese technology startup incubated at neoBay which focuses on smart visual checkout systems empowered by AI technology (Sodexo Venture n.d.)

5 Idea of International Ecosystem for Innovation and Entrepreneurship (IEIE) Enlightened by BRI

5.1 New Opportunities Brought About by Belt and Road Initiatives

The Belt and Road Initiative (BRI) is a program to "connect Asia with Africa and Europe via land and maritime networks along six corridors to improve regional integration, increasing trade and stimulating economic growth." (EBRD n.d.). It connects "two of the world's largest economies, China and Europe. The route will emerge as a major logistics corridor and create new opportunities for Central Asia and Eastern Europe as both a transshipment hub and commodities supplier" (Wong and Jia 2017).

There are new opportunities brought about by BRI. For example, Chinese startups will benefit from the improvement in infrastructure across the BRI region; The potential market in terms of electronics, internet and real estate, rising middle-class and established distribution networks will be the perfect opportunities for Chinese startups and big corporates to develop their business aboard; BRI will accelerate Chinese acquisitions of European industrial technologies; BRI will benefit electronics and technology products: Investments in power and ICT will boost the BRI region's demand for Chinese electronics and technology products, such as smartphones and increasing Internet of Things; (Wong and Jia 2017).

5.2 Brief Introduction to International Ecosystem for Innovation and Entrepreneurship (IEIE)

Inspired by the idea of complex system and its evolution, with the willingness to bring about the contribution to "the Belt and Road Initiative", neoBay and other institutions, such as the universities, the incubators, the science parks from East Europe and South East Asia co-initialized International Ecosystem for Innovation and Entrepreneurship (IEIE) in Belgrade, Serbia on the occasion of the Fourth China-CEEC Conference on Innovation Cooperation on 09th October 2019.

Based on equality and double-win principles, IEIE is designed to resource sharing, technology transfer, co-incubation, and matchmaking in the international market, aiming

to establish a sustainable and reciprocal complex system, which enrolled 9 institutional members from different countries on the date of its foundation.

5.3 IEIE Development and Its First Results

Increase of Number of IEIE Members. Regardless of the Pandemic breakout during the first quarter of 2020, IEIE has been keeping its growth in the number of members by enrolling Ming Innovation (German incubator headquartered in Kaiserslautern), emlyon business school (a French business school with its campus across the globe) and Institute of Innovation & Entrepreneurship, Singapore Management University.

Development of the IEIE Online Platform. Meanwhile, neoBay is devoted to the development of the IEIE online platform in favor of IEIE membership acquisition, resource searching, matchmaking and technology transfer. The users' IDs on this online platform are categorized as Secretary-General, IEIE Website Administrator, IEIE Members, Institutions and Visitors (Ordinary internaut), each of whom has different priorities on this website. IEIE online platform's significance is to bring together all the IEIE members, resources that they are willing to share, announcements of IEIE online & offline events and the news in terms of research findings, collaboration and significant events, etc. In other words, IEIE takes advantage of Internet technology to accumulate all the resources dispersing temporally and spatially to build up a complex system, shortening the distance between the nodes by folding their coupling (ex: IEIE members, other institutions non-enrolled in IEIE, individuals), densifying the distribution of resources in innovation and entrepreneurship and setting up the collaborative mechanism with no boundary and accessible to all.

Organization of IEIE | Think Tank. In addition, IEIE has so far organized the three sessions of IEIE | Think Tank with other IEIE members. The topic for the first session is "The World after the Pandemic", which was discussed around various aspects such as digitalization, innovation, supply chain and ecosystem. The second session is about "Idea, strategy, technology and business plan to address new challenges". The third one is relevant to student entrepreneurship. These series of online events have attracted nearly around 260 attendees, most of whom are students, professors, entrepreneurs and executives of big corporates worldwide.

Proposition of IEIE Operation Mechanism. The first IEIE delegation meeting has proposed the four proposals for IEIE operation mechanism, which concern Contact Person - connector between each IEIE member and IEIE ecosystem as a whole for communicating, informing and coordinating, IEIE Passport – allowing all the startups attached to each member to access all the resources coordinated by IEIE, Improvement of Think Tank organization and Division of missions and task assignment.

To democratize decision, IEIE highlights participation of all the members through the procedure of inquiring, collecting, questioning, and analyzing the ideas and the suggestions from all the members around these four proposals with a mindset of objectivity.

5.4 IEIE's Perspective for the Future

The future of IEIE will base on the following pillars serving all the IEIE members across the globe.

Startup-Oriented Service in Favor of Their Resourcing and Matchmaking. One of the essential missions of IEIE members is serving the startups. Therefore, the startups' first concerns and their sustainable growth would be the goals of resourcing and matchmaking in IEIE.

Market-Oriented Technology Transfer. The significance of discovery in science and technology is related to its application, and the correspondence between the core technology and its market segment would be the priority of technology transfer.

Digitalization and Global Networking. Initialized by the idea that IT and AI could eventually replace a massive amount of repeated tasks previously undertaken by human beings, digitalization would be the first necessity in IEIE's operation, and it could further contribute to IEIE's global networking.

Large Quantity, Flexibility and Decentralization. All the activities regarding resourcing, matchmaking, technology transfer and event co-organization should be in large quantity. All the coupling and collaborations should be realized flexibly and in a decentralized modality, ensuring IEIE's self-consistency and self-adaptive ability to the ever-changing outside environment.

6 Future Research and Possible Limitations

6.1 Research Orientation in the Future

Based on IEIE's perspective for the future as well as the current suggestions from IEIE members, the future research lies in the following issues.

As IEIE is a startup-oriented and worldwide ecosystem, how can IEIE define the relationship among the startup/entrepreneur attached to an IEIE member (Level 1), the IEIE member (Level 2) and the IEIE as a whole (Level 3) through the operation mechanism of IEIE Passport? Even if IEIE is an open ecosystem, the boundary should be taken into account to improve the efficiency of its operation mechanism. In other words, what kind of entrepreneurial projects and new technologies can be classified into the IEIE ecosystem in accordance with the existing resources and the circumstances? As each IEIE has its own network/sub-ecosystem, how can IEIE integrate each sub-ecosystem around each into IEIE as a whole in a decentralized and flexible modality?

6.2 The Possible Limitations

The possible limitations in future research concerns:

Sample Bias. Does the information contributed by each IEIE member cover the whole situation of the local market, the demand of the startups in that country, etc.?

Research Method. Can the current method in terms of inquiring, collecting, questioning and analyzing really reveal the truth? Any other possible methods to adopt?

7 Conclusion

As mentioned at the beginning of this paper, homo sapiens collaborate under the common belief to address worldly problems thanks to the Cognitive Revolution. Given complex system evolution, the mindset for interactions among different nodes, folding and system creation is indispensable in innovation and entrepreneurship. The rapid growth of neoBay Global Innovation and Entrepreneurship Community in the past five years proves the significance of collaboration, folding and ecosystem, these three factors favoring not only the startups incubated but also neoBay itself.

With its global vision and under the background of the Belt and Road Initiative, neoBay co-founded with its international partners the International Ecosystem for Innovation and Entrepreneurship (IEIE), the objectives of which are resourcing, matchmaking and technology transfer with perspectives of startup-oriented services, market-oriented technology transfer, digitalization and global networking. Together, we will build up a global collaborative mechanism featured by large quantity, flexible and decentralized modality. Nevertheless, global collaborations in innovation and entrepreneurship are not confined only to our methods. Therefore, other ideas, methodologies and even various effective ways in global collaboration via ecosystem will be studied, questioned, analyzed, reasoned, applied and appreciated.

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Social Media Advertising During the Pandemic: Online Retailers in Serbia

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Abstract. With the global spread of COVID-19 in the first half of 2020 and new government measures introduced on almost daily basis, people living in Serbia were experiencing changes in their everyday life, including their shopping habits. Organizations were facing a potential economy crisis, but also changing customer attitudes and behaviors. In this paper, social media advertising of online shops during COVID-19 pandemic of Serbia's top 10 retail companies based on their total number of retail shops is examined. The mixed method approach was used. First, it was determined whether these retail brands previously had online shops, or online shops were opened in response to the crisis. Quantitative data about e-commerce website traffic was examined with SimilarWeb tool, while qualitative data about advertising on social media was collected from Facebook Pages and Facebook Ads Library (total of 493 Facebook posts and 138 Facebook ads). The results suggest that increase in online shops' website traffic in April and May can be interpreted as a reaction of customers who were not able to go shopping at the time of crisis. By publishing content that primarily promotes their brand values, online retailers missed the opportunity to use social media as a communication channel to raise awareness about the benefits of online shopping, so that customers who started to shop online due to the crisis, would continue to buy groceries online even after quarantine ended. Serbian retail brands during this crisis relied on existing online shopping users and their electronic word-of-mouth marketing.

Keywords: Social media advertising · Online shopping · COVID-19

1 Introduction

The outbreak of coronavirus disease (COVID-19) was identified in December 2019 in Wuhan, China. It was declared a pandemic by World Health Organization on March 11, 2020 [1]. As the COVID-19 pandemic began to flare up, a number of countries have implemented firm measures to fight the further spread of the disease. Restrictions such as curfew, lockdowns, as well as nationwide lockdowns were established and many people were spending time in quarantine and are being asked to keep social distance [2].

The first coronavirus case in Serbia was confirmed on March 6. Serbia responded on March 11, by restricting entry for foreign countries that were coming from countries affected with intensive coronavirus transmission. On March 16, the state of emergency

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 16–23, 2022.
http://doi.org/10.1007/978-3-030-97947-8_3

was declared and four days later the borders were closed. The 24-h curfew for residents over 65 in urban areas and 70 in rural areas was introduced on March 18, and the mandatory curfew for all residents from 8 pm to 5 am. The mandatory curfew was extended on March 22 - from 5 pm to 5 am [3].

With new Government measures introduced on almost daily basis, people were experiencing changes in their everyday life, as well as their habits. On the other hand, organizations were facing potential economy crisis, but also with changing customer attitudes and behaviors. As the number of confirmed COVID-19 cases in Serbia rose exponentially, interest for the search term "online shopping" (in Serbian: "*online kupovina*") showed the similar trend [4].

2 Social Media Advertising and Online Shopping

The expansion of Web 2.0 at the beginning of the millennium enabled emergence of new websites and web applications based on new possibilities for interactivity, online communication and collaboration. The group of web-based applications that are established on foundations of Web 2.0 and allow creation, distribution and exchange of content generated by users is defined as social media [5].

The following emergence of social media changed not only business-to-consumer, but also consumer-to-consumer communication, allowing consumers to connect and communicate directly, regardless of geographic distance. Keeping this in mind, some authors began to consider social media as a hybrid element of the traditional promotional mix [6]. Differences between traditional and social media advertising spent have been argued. In traditional marketing, the media budget is divided into various media channels that deliver messages directly to customers, while in social media marketing messages are delivered to customers who continue to spread this brand-related content [7].

Different studies investigated shopping intentions on social media. Mikalef et al. found that browsing intention on social media is significantly positively connected with purchasing and word-of-mouth intention, confirming that social media can be successfully used in marketing strategy, resulting in increased sales [8]. Other study pointed out that, while browsing social media, consumers are in the state of constant consideration of potential purchase and evaluation of different providers of goods and services [9].

Zhang et al. investigated the connection between usage of social media and shopping activity. They found out that greater cumulative usage of social media sites is positively associated with online shopping activities [10]. Vithayathil et al. [11] investigated the associations between social media use at home and online shopping preferences in popular retail companies. These authors found out that use of Facebook at home is positively associated with online shopping at Amazon, while Twitter usage is positively associated with online shopping at Best Buy.

3 Method

In this paper, social media advertising of online shops during COVID-19 pandemic is analyzed through: (1) estimated total website traffic, (2) estimated website traffic coming from specific sources and (3) the content of Facebook posts and Facebook ads.

The research questions are:

- **RQ1:** Did traffic to retailer brand's online shops increased during the peak of COVID-19 pandemic?
- **RQ2:** Did online retailers successfully used social media advertising in order to increase online shop website traffic?

Exploratory research approach was used, while both primary and secondary data was examined.

3.1 Data Collection

In the first step, top 10 retail companies in Serbia were identified based on the total number of stores in 2018: (1) Delhaize (Maxi, Tempo, Shop&Go), (2) Mercator-S (Mercator, Idea, Roda, VELPRO), (3) Aman, (4) Gomex, (5) TSV Brave (TSV), (6) BB Trade (PerSu), (7) Podunavlje AD (Podunavlje), (8) Mikromarket, (9) Univerexport and (10) Transkom 94 [12]. Secondly, it is determined whether these retail brands previously had online shops or online shops were opened in response to the crisis.

Retail company's websites were analyzed and it is noted that only 50% of top ten retail companies had online shops: *Maxi*, *Idea, PerSu, Mikromarket* and *eLakolije*. *Maxi*, *Idea* and *eLakolije* had online shops before pandemic, while *PerSu* and *Mikromarket* were opened in response to the crisis.

In the following step, quantitative data about e-commerce website traffic was collected and examined with SimilarWeb platform (www.similarweb.com). This is a benchmarking tool that uses multi-dimensional approach. It combines partnerships, public data sources, anonymous behavioral data and first-party direct measurement that provides market intelligence and ready-to-use insights about website traffic. The following variables were examined: (1) *total number of visitors* – estimated number of visits from all traffic sources; (2) *direct traffic* – estimated number of visits that arrived directly on a website; (3) *referral traffic* – estimated number of visits coming from other domains; (4) *search traffic* – estimated number of visits directed from search engines; (5) *social traffic* – estimated number of visits that originated on social media websites; (6) *mail traffic* – estimated number of visits driven to a website via e-mail marketing campaign.

Qualitative data about advertising on social media was collected from retailer's Facebook Pages and Facebook Ads Library. The total of 493 Facebook posts and 138 Facebook and Instagram ads were examined. Facebook posts and Facebook ads were categorized based on their content. As suggested by Cvijikj et al., in order to remove bias from different interpretation of post content, the post categorization has been executed by a single researcher, while two additional researchers discussed the final categories [13]. Facebook posts and ads were categorized in the following groups: (1) *online shopping* – posts that feature or include link to the online shop; (2) *product* – posts that feature or promote a specific product; (3) *offer* – posts that feature promotional offer of discounts; (4) *company info* – posts that feature information about company; (5) *CSR* –posts that feature corporate social responsibility activities; (6) *COVID-19 info* –posts and that feature information such as changed work hours, special measures etc. (7) *COVID-19 advice* – posts that feature advice on good practices to combat epidemic; (8) *Stay at*

home – posts with creative ideas for people in quarantine; (9) *Giveaway* – posts that promote giveaways and prize pools.

Data collection and analysis for Facebook posts was executed from March through June 2020 by examining retail brands' Facebook Pages, while monitoring for Facebook and Instagram ads was executed daily in April 2020 with Facebook Ads Library.

4 Results

Descriptive statistics was used to present the basic features of data collected in this research: website data of online shops and Facebook posts and ads analysis.

4.1 Website Traffic Analysis

Website data was collected with SimilarWeb platform and the traffic data on desktop is presented in Fig. 1.

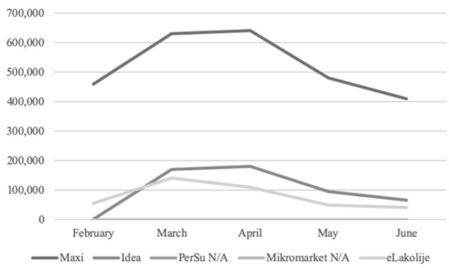

Fig. 1. Total number of visitors to online shops from February to June 2020.

For *PerSu* and *Mikromarket* websites there was no sufficient data for SimilarWeb to perform traffic estimation. This is expected given that the two websites were launched only a month before this research was conducted.

The results show that all three online shops recorded increase in website traffic in March 2020. *Maxi* had the highest number of total visits followed by *Idea* and *eLakolije*. *Maxi* and *Idea* online shops showed a slight increase in website traffic in April, while *eLakolije* had traffic decrease. Examined websites showed traffic decrease from April that continued through June 2020.

The traffic source analysis (Table 1) indicate that marketing strategies of all online shops are focused primarily on Search with more that 50% of traffic coming from that channel, followed by Direct traffic. Social media sources have less than 5% share in total traffic. Social media traffic is detailed in Table 2.

Maxi and *Idea* get their social media traffic mostly from Facebook (over 70%), followed by YouTube. On the other hand *eLakolije* gets over 50% from YouTube, followed by Facebook (40%). Instagram and Twitter are not generating significant traffic for these online shops (less than 2%).

Table 1. Online shop traffic sources on desktop devices

	Direct	Referrals	Search	Social	Mail
Maxi	28.53%	0.95%	64.18%	2.41%	0.25%
Idea	14.91%	12.07%	70.10%	0.32%	0.75%
PerSu	N/A	N/A	N/A	N/A	N/A
Mikromarket	N/A	N/A	N/A	N/A	N/A
eLakolije	38.41%	3.12%	53.31%	2.98%	2.18%

Table 2. Online shop social media traffic sources on desktop devices

	Facebook	Instagram	Youtube	Twitter
Maxi	83.83%	0.12%	16.05%	0.00%
Idea	74.77%	0.00%	25.23%	0.00%
PerSu	N/A	N/A	N/A	N/A
Mikromarket	N/A	N/A	N/A	N/A
eLakolije	42.32%	1.73%	55.28%	0.66%

4.2 Facebook Post and Ads Analysis

Facebook post analysis gave us an insight into retail brands' social media communication strategy during COVID-19 pandemic peak in Serbia (Table 3).

Maxi Facebook page has 257.732 likes (as of July, 2020). In March 2020, *Maxi* had the largest number of posts in COVID-19 info and Product categories. During April, Maxi's strategy focused on creative Stay at home posts, COVID-19 info and CSR activities. In May, *Maxi* focused on Product posts. The total of 2 posts about online shopping were published. *Maxi* published the average of 0.77 posts per day.

Idea Facebook page has 161.187 likes (as of July, 2020). In March 2020, *Idea* had the largest number of posts in Product and COVID-19 info categories. During April, *Idea*'s strategy focused dominantly on Stay at home posts and CSR activities. In May, *Idea* focused on Product posts, but on Stay at home posts as well. On March 25, the pick-up feature was introduced, and the partnership with *Glovo* delivery app was launched on April 30. The total of 14 posts about online shopping were published. Idea published the average of 2.03 posts per day.

PerSu Facebook page has 58.421 likes (as of July, 2020). In March 2020, *PerSu* had the largest number of posts in COVID-19 info and Offer categories. During April, *PerSu*'s strategy focused dominantly on COVID-19 info and Offer categories. In May, *PerSu* focused primarily on Offer posts. On April 15, home delivery was introduced, while online shop was launched on May 1. The total of 3 posts about online shopping were published. *PerSu* published the average of 1.16 posts per day.

Mikromarket Facebook page has 5.944 likes (as of July, 2020). In March 2020, *Mikromarket* had the largest number of posts in Offer and CSR categories. During April,

Mikromarket's strategy focused on Offer, COVID-19 info and Online shopping. In May, *Mikromarket* published few posts from Product, Offer and Company info categories. Online shop was launched on April 6. From The total of 2 posts about online shopping were published. *Mikromarket* published the average of 0.26 posts per day, during the three-month period.

Facebook page *eLakolije* has 95.952 likes (as of July, 2020). From March to the end of April 2020, *eLakolije* had the largest number of posts in Product, COVID-19 info, Stay at home categories and the total of 4 posts about online shopping feature were published. It is important to mention that *eLakolije* also published post about delivery delays due to a reduced number of delivery time slots. Online shop *eLakolije* published the average of 0.26 posts per day.

Table 3. Facebook posts by post category (March-June)

	Maxi			Idea			PerSu			Mikromarket			eLakolije		
Month | Post type	03	04	05	03	04	05	03	04	05	03	04	05	03	04	05
Online shopping	1	0	1	1	6	7	0	1	2	0	2	0	1	0	3
Product	5	4	10	12	2	25	5	1	6	0	0	2	9	7	17
Offer	1	0	0	3	0	3	8	9	15	5	3	2	2	1	5
Company info	1	1	2	2	3	1	2	7	3	1	0	2	0	2	7
CSR	1	5	0	1	9	2	7	1	0	4	0	0	1	6	0
COVID-19 info	8	6	0	11	4	2	10	12	2	0	2	1	6	8	0
COVID-19 advice	1	0	0	4	2	0	2	0	1	0	0	0	2	3	1
Stay at home	1	16	4	5	66	15	1	8	2	0	0	0	3	16	0
Giveaway	3	0	0	1	0	0	2	0	0	0	0	0	4	0	0
Total:	22	32	17	40	92	55	37	39	31	10	7	7	28	43	33

Furthermore, Facebook and Instagram ads analysis gave us insight about focus of paid social media strategy during COVID-19 pandemic peak in Serbia (Table 4). The largest number of ads were placed by *Maxi* and *eLakolije*. *Maxi*'s ad strategy was focused on Online shopping and Product promotion, while *eLakolije* focused on promoting Company info. *Idea* and *eLakolije* had no ads about online shopping during the research period.

Table 4. Facebook and Instagram ads by post category (March-June)

	Maxi		Idea		PerSu		Mikromarket		eLakolije	
	FB	Insta	FB	Insta	FB	Insta	FB	Insta	FB	Insta
Online shopping	14	3	0	0	1	2	1	1	0	0
Product	14	15	2	1	1	3	0	0	5	8
Offer	4	2	4	2	0	0	1	1	8	6
Company info	5	3	0	0	0	2	2	1	22	7
CSR	0	0	4	4	0	0	0	0	0	0
COVID-19 info	0	0	0	0	0	0	0	0	0	0
COVID-19 advice	0	0	0	0	0	0	0	0	0	0
Stay at home	0	0	0	0	0	0	0	0	0	0
Giveaway	2	1	0	0	2	0	0	0	0	0
Total ads	63		16		11		7		41	
Total placements*	63		17		11		7		56	

*One ad can have placement both on Facebook and Instagram.

5 Discussion

The results of this study gave us valuable insight into how the biggest Serbian retailers promoted online shopping on their social media during COVID-19 pandemic in response to consumers' lifestyle change.

Reports from The Statistical Office of the Republic of Serbia from 2019 state that around 60% of Serbian citizens use Internet, but only 30% experienced online shopping [14]. During COVID-19 pandemics, the number of first-time Internet shoppers increased up to 30% (www.netokracija.rs). This observed increase in online shop's website traffic in April and May can be interpreted as a reaction of customers who were not able to go shopping due to long lines at stores and shortened working hours. This conclusion is also confirmed by following decline in website traffic in June, when restrictions regarding the number of persons that were allowed in the store were lifted, and working hours were extended. The results also suggest that online retailers adjusted social media plans by publishing content that primarily promoted their brand values. The relatively small number of posts and ads in online shopping category, as well as the largest part of traffic coming from Search and Direct sources, indicate that Serbian retail brands rely on existing online shopping users and their electronic word-of-mouth marketing. Online retailers missed the opportunity to use social media as a communication channel to raise awareness about the benefits of online shopping, so that customers who started to shop online due to the crisis, would continue to buy groceries online even after quarantine

ended. During the time of crisis, only brands that promptly respond and adapt to changing conditions will emerge with less consequences than others. Innovativeness is very often seen as an important part of many brands' mission and vision statements so, in these challenging times, brand evolution becomes an imperative.

At the end, it is important to emphasize methodological limitations of this paper that rise from the lack of available data. This research was conducted on secondary data based on estimations of website traffic, but insight into primary data collected directly on the websites would be more reliable.

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The Impact of Digitalization on Quality Management in Health Systems: New Challenges and Opportunities

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Abstract. Developed countries face a twofold challenge that is to be addressed by implementing existing digital technologies. Digitalization offers benefits in both financial sustainability and improved quality, unlocking substantial value as a result. Despite having the ability to technologically implement new digital solutions, it is not done comprehensively. In many ways, nontechnological hurdles as well as sectorial grown, stiff structures and regularizations prevent a dynamic application of reforms and new provisions. Consequently, health care lacks behind industry when it comes to utilization of the digital transformation to extract further actionable insights, a deeper understanding of streamline processes and to ultimately deliver improved patient care. The purpose of this paper is to reveal new challenges and opportunities of the digital revolution in health systems by the identification of praxis-related, target-oriented defiance and further research opportunities.

Keywords: Digitalization · Quality management · Health systems

1 Introduction

Digitalization is in full swing providing disruptive potential for value creation [1, 2] and jeopardizing those not participating in the transformation [3, 4]. Healthcare is no exception. [5, 6] Digitalization offers benefits in both financial sustainability and improved quality, unlocking substantial value as a result. [6, 7] Despite having the ability to technologically implement new digital solutions, it is not done comprehensively. In many ways, nontechnological hurdles as well as sectorial grown, stiff structures and regularizations prevent a dynamic application of reforms and new provisions. Consequently, health care lacks behind industry when it comes to utilization of the digital transformation to extract further actionable insights, a deeper understanding of streamline processes and to ultimately deliver improved patient care. [8] The purpose of this paper is to reveal new challenges and opportunities of the digital revolution in health systems by the identification of praxis-related, target-oriented defiance and further research opportunities.

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 24–31, 2022.
http://doi.org/10.1007/978-3-030-97947-8_4

2 Research Design

Focus groups were found to be a valid tool for elucidating current perceived nontechnological hurdles and challenges in health systems quality management. Data was collected from two focus groups, with a total of 15 participants involved. Participants were representing medical centers, orthopedics and rehabilitation, emergency medical service, pharmacy, medical laboratories, nursing, home care and medical engineering. Thematic analysis of aggregated data was applied and compared with results of a systematic literature review on industry's digital opportunities, barriers and risks.

2.1 Focus Groups as a Qualitative Research Method

Qualitative interviews are one of the most popular methods used in empirical research [9]. Focus groups, as a rather uncommon form of qualitative research [10], are group interviews at its core, although not in the sense of an inquiry-response cycle [11, 12]. Rather the researcher takes on the role of a moderator than of an interviewer. Kruger and Casey describe it as "a less directive and dominant role" [12], giving space to open-ended questions and group interaction. This allows for a deeper exploration of problems [13, 14] and is particularly suited for the consolidation of existing knowledge, the generation of new information or to explore the depth and nuances of people's opinions on a topic [15, 16].

The general idea behind focus groups is based on the assumption that participants with a shared problem are more willing to discuss it in a sheltered group than in a one-on-one interview situation [13, 17, 18]. Morgan emphasizes that in contrast to other group methodologies, that do not involve group interaction, like Delphi Groups, focus groups rely on participants discussions and interactions [19]. The opportunity to express approval, to add additional information to or to show disagreement with another participants response, give additional insights into why and how people feel about an issue under investigation [13, 20]. Furthermore, group interactions forces interviewees to reconsider and reevaluate their own statements [21]. Therefore, focus groups are more than aggregated individual contributions in one-on-one interviews [17, 18].

Although focus groups are usually used for qualitative research only [12, 18], it can be employed in the collection of quantitative data as well [10]. According to Morgan [19] the majority of focus groups are paired with other research methods. Consequently, focus groups offer a great deal of flexibility in its implementation and ask for an adaption and transfer to the current situation [22, 23].

2.2 Selection of Experts and Ethical Considerations

In order to address the research question and to gain first insights into the complex topic of digitalization's influence on quality management in health systems, a careful selection of participants is crucial. Due to the research design, these focus groups as such cannot produce representativeness in a statistical sense. Although participants share personal experiences with and nuances of their individual opinion on the influence of digital transformation on quality management, the focus lies on the representability of the content, instead. [16, 24] This assumes that participants are rather representatives of the

group under investigation than representing individual cases. Therefore, the purposive selection of typical cases is crucial. Members of the health system were eligible to participate if they 1) are an active member of health care industry 2) hold a position that grants them exclusive access to information on quality management and digitalization, 3) were willing to give informed consent, 4) were able to speak and understand German. Participant were recruited in the greater region of Koblenz, that applied for the German Digital Health Hub, and the commuter belt of the BTU Health Campus, that is center of many optimization projects in the field of health and digitalization [25].

Focus groups expose participants to the judgment of fellows with skilled moderators trying to persuade them to reveal intimate views, feelings and gathered experiences. [26] Therefore, consent is a central ethical concern in focus groups and serves as legitimizations of researchers' actions. [27] All participants took part on a voluntary basis after confirming their participation through mail. After researchers explained what the gathered information is used for and to what extend it will be disclosed to others, participant gave written consent. Furthermore, confidentiality is ensured by access restrictions on the data and anonymous analysis of transcripts. The study was neither registered nor reviewed by an ethics committee.

2.3 Data Collection and Procedure of the Focus Groups

The focus groups were conducted on 2nd April in Cottbus and on 9th April 2020 in Koblenz. Both sessions lasted approximately two hours until attainment of saturation [14]. By choosing two different locations – one in the very east, the other in the very west of Germany – environmental influence on the place of work and participants stance is captured. Furthermore, difference in legal requirements, like restrictions on remote treatment, influence the discussions [28].

A semi-structured guideline was used which was divided into categories including an short introduction to digitalization, an initial exploration of quality management in participants working environment and a comparison of quality management with other industries. Subsequently open-questions led the discussion to the influence of digitalization on quality management and participants were asked to present consequences for quality representatives triggered by digitalization. Finally, discussed themes were prioritized by participants.

Because focus groups are group interviews, a moderator is essential [11, 23]. Consequently, one of the researcher takes on the role of a moderator with special attendance to the relationship developing between group members and encouraging interaction of all participants [29, 30]. Further, strategic summarizations were used to facilitate refinement of the groups point of view and individuals explanations. The researchers audiotaped ideas discussed and generated by participants. The verbatim, anonymized transcripts were matched with the protocol of nonverbal communication and analyzed based on the method proposed by Kuckartz [31]. Basically, the records are divided into thematic main groups, which are subsequently divided into further so-called subcategories. Statements from the focus groups are assigned to these. The final step involves visualizing and interpreting of the categorized information.

2.4 Contrasting Juxtaposition with Current Literature

Prioritized findings from the focus group interviews are compared with the current state of research in order to be able to assess whether the perceived hurdles, challenges and problems can be solved by state of the art digital solutions and whether its practical use is associated with certain risks and barriers. The existence of a technical solution that is not in the field often indicates nontechnical hurdles that are worth further investigation. The purpose of the comparison is the identification of research opportunities, which do not necessarily refer to technical solutions only, but usually address nontechnical barriers, on top. Due to the rapidly increasing number of publications on digitalization, a systematic approach to analyse existing literature is indispensable [32]. Therefore, Cooper's literature review process serves as a framework, in order to guarantee a solid deduction of research gaps based on focus groups results [33].

3 Result

In order to systematically evaluate results from the focus groups, participants perceived, praxis related problems are divided into the following mutually exclusive groups during the literature review:

1. Problems that can be addressed by existing digital solutions.
2. Problems where new digital solutions are needed.

While the latter point gaps for technical solutions out, the former hints at problems in implementation or in the execution of digitalization strategies. Many problems described by participants can be addressed through existing technical solutions. Nevertheless, there is a discrepancy between the latest high-performance medicine, such as augmented reality robots, and the lethargic structures of the predominantly analogy indirect processes [34, 35]. The use of technical solutions in direct patient contact is intended to counteract the shortage of specialists [36] and, through more efficient implementation, to give the caregiver more time to work on the patient [37, 38]. So far, however, the potential of countless data sources is untouched [36]. Consistently, the databases for trend analysis and the development of key performance indicators (KPI) are missing. Participants demand methods to measure patient's satisfaction and wishes with special emphasis and request support with the introduction and selection of suitable IT systems, e.g. data management systems, in the first place. As a result, duplicate workflows are eliminated and processes become more efficient, secure and effective. [8, 28]. For further particularization participants perceived, target-oriented defiance and risks are matched with the results of the review. A total of eight areas were identified, with 31 key topics that must be addressed for further improvements in health care's quality management. Insights are summarized in Fig. 1.

In Germany in particular, legal regularizations not only prevent e-prescriptions or nationwide telemedicine, but also a dynamic adaption of digital technologies [36]. Participants accentuate that people must demand the digitalization of health systems in order to initiate the application of dynamic reforms, provisions and nationwide general

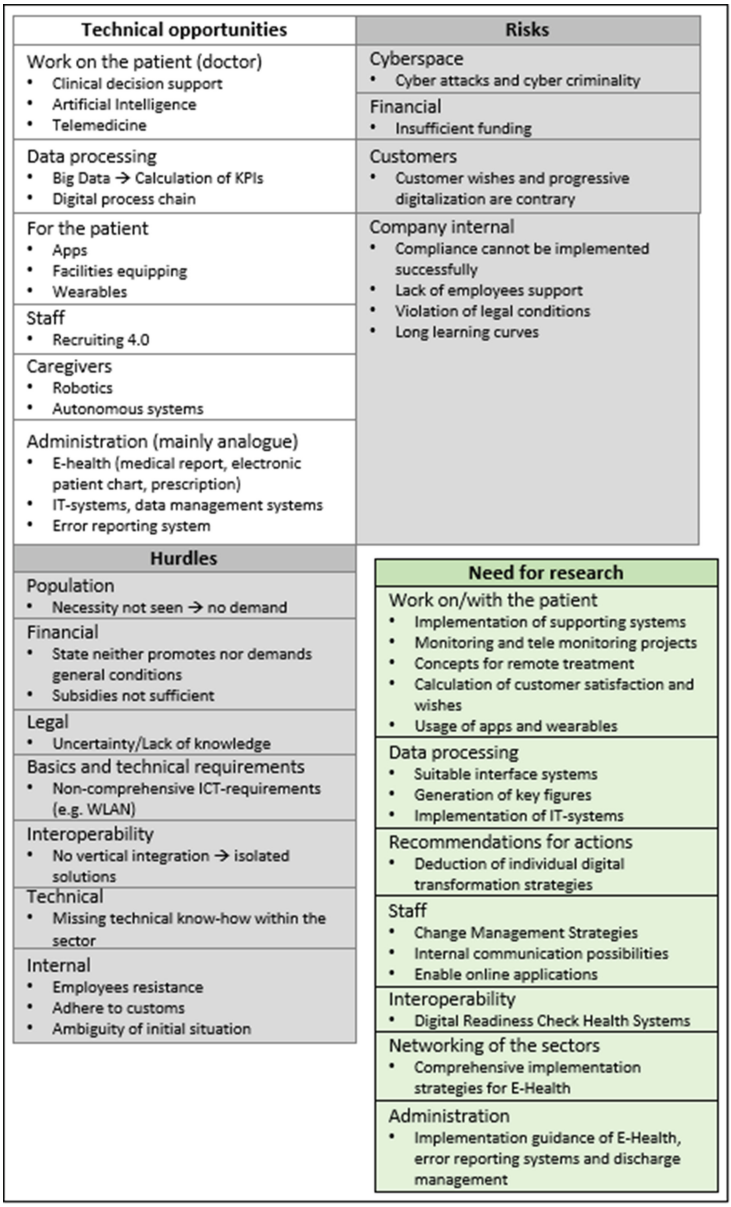

Fig. 1. Summary of results based on focus groups and literature review

conditions. However, due to the black-box like structure of the health system, there is no initial impetus from the population [35, 39].

Results show that an essential need is in the area of structural quality. A target-oriented and sustainable implementation of quality enhancing measures presupposes a comprehensive work on general conditions and a structured approach for implementation.

4 Discussion

Although many aspects inhibit the digital transformation in health system's quality management, weighing opportunities, risks and hurdles the technical possibilities predominate. Nevertheless, a wide gap in implementation exists. This can be attributed to the enormous complexity of the health care system and legal restrictions, but it is particularly due to existing ambiguities regarding an individuals digital status quo. Therefore, a methodology for assessing digitalization readiness is needed. Existing maturity models and assessments are not tailored to health systems [40]. Particular emphasis should be on the human factors, vertical and horizontal integration as well as a detailed investigation of existing processes [41]. In addition, to its descriptive purpose the methodology should focus on the identification of further measures and the definition of an individual's digital maturity level. Any digital strategy or measure should be based on takeaways from these assessments moving within the triangle of legal limitations, populations perceptions and comprehensive integration. In this way, the implementation of customer-driven, quality enhancing measures is possible, without risking isolated solutions that are contrary to the development of standards. A key challenge in this context is to develop methods that facilitate a dynamic elimination of non-technical hurdles within these sectorial grown, stiff structures and existing regularizations to enable dynamic application of further technical and non-technical measures in the future. Focus groups showed that the selection of digital technologies is a major challenge. Many digitization projects are nipped in the bud, because those responsible are put off by the large pool of existing technical solutions. A kind of digital improvement centre to select apposite technical solution for the individual case would be desirable. The need for selection assistant includes the selection of precisely fitting algorithms in the context of artificial intelligence, machine learning and data mining to ensure a structured and sustainable implementation.

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Deduction of Digital Transformation Strategies from Maturity Models

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Abstract. Nine out of ten business leaders plan to gradually increase their companies' digital maturity. However, many struggle to pick from a wide range of promising digital solutions, facing major uncertainties with regard to a specific digital transformation strategy. Especially, Small and Medium-Sized Enterprises, rather stick to stand-alone solutions than developing comprehensive digital strategies. The purpose of this paper is to deduce digital transformation strategies in SMEs incorporating maturity models. The latter are often starting point to determine the status-quo of digital maturity and to deduce stand-alone measures. Although the content of digital maturity models is constant, the level of majority is dependent on the company's strategy and operating model. Thus, maturity models can serve as a validation tool in an agile digital-strategy practice.

Keywords: Digital transformation · Maturity model · Digital strategy

1 Introduction

Digitalization is a major trend across all industries. Its importance is undisputed. Companies across all sectors are concerned with digital strategy, although still in its infancy at presence [1]. Many struggle to pick from a wide range of promising digital solutions, as the nature of technical, economic and social processes changed drastically with the progressively digital transformation [2]. Consequently, an appropriate assessment method is needed to cope with the huge number of digital solutions and to guide Small and Medium-Sized Enterprises (SME) out of their comfort zone [3]. Although a single digital strategy is crucial, defining target levels one has to distinguish between organizational enablers and distinctive technical capabilities serving as enablers for, and future digitized solutions. Digital maturity models are a promising approach to assess the digital as-is situation and to determine a suitable target position for the deduction of suitable digitalization projects [4]. Therefore, this paper attends the purpose to incorporate digital maturity models to address existing hurdles of current approaches for the development of digital transformation strategies.

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 32–39, 2022.
http://doi.org/10.1007/978-3-030-97947-8_5

2 Theoretical Background

2.1 Ambiguity on Digital Transformation and Digitalization Strategies

Digital strategy and digital transformation are terms frequently used in current, predominately practice-oriented, literature [5]. However, both concepts lack a commonly accepted definition [6] and are often used interchangeably with terms such as digitalization, digitization or digital transformation [7]. Despite similarities and interrelations, it is essential to distinguish for a consistent use of terminology [8]. Digitization essentially refers to converting analogue information into a digital format, while digitalization refers to the way business and society changes through the use of digital technologies [9]. In a business related context, digitalization is about leveraging digital technologies to revise processes, products and user experiences [8] Thus, digitalization is a customer-driven process that changes technical and social aspects and therefore goes beyond a plain technical transformation [10]. The goal of digital transformation is to reach digital maturity, which defines a state of ability to achieve the desired transformation [11]. To put it in a nutshell, we digitize information, digitalize elements of business operations and digitally transform business models and strategies. A company's digitalization strategy besides digital transformation objectives contains guidelines, plans, controlling structures and most important a digital vision [12]. Therefore, many consider it to be part of a company's business strategy [13]. A digital strategy is the strategic roadmap to cope with all digitalization projects within a company and is the strategic answer to a digital transformation.

2.2 Maturity Models as a Tool to Assess Digital Maturity

The goal to reach digital maturity plays an important role for a company's digital vision and therefore for the deduction of digital strategies [14]. On the other hand, digitally maturing companies are more likely to have a clear and inherently consistent digital strategy [15]. However, to define a company's individual level of digital maturity it is essential to determine the status quo.

In general, maturity models are characterised by

- A structured manner to determine the concrete situation of valuation
- Incentives and measures to systematically improve capability levels
- Capabilities to monitor successful implementation of specified measures [16]

Consequently, maturity models do not only describe an evolutionary path to a state of perfection based on the status quo, but also act as an instrument to evaluate the degree of progress to reach maturity [17]. Because maturity models are a suitable tool to assess skill levels, to systematically, improve capability levels and to monitor these measures, they constitute a practicable instrument alongside digital transformation.

Recently maturity models became a popular tool when it comes to assess SME's digital maturity [4, 18]. As a special class of reference models, digital maturity models describe an evolutionary path to a desirable state within the context of digital transformation [11, 16]. This state is known as digital maturity representing the ultimate goal of the

transformational process [19]. Initial practice-oriented research proposed plenty scales and archetypes to assess digital maturity in SME [20]. A solid overview of the diversity is conveyed by Akdil et al. [21], Mittal et al. [4], Chanias & Hess [20] and Carolis et al. [22]. Although maturity models characteristics vary significantly, the majority relays on similar revalidated procedures and instruments.

2.3 Existing Approaches on Digital Strategies

In order to obtain clear insights on the state of the art, an extensive comparison of literature was conducted. Current literature proposes several different approaches for the development of digital strategies, which in general are composed of four generic phases.

1. Determination of initial situation
2. Definition of target picture
3. Deduction of digitalization measures
4. Implementation of digitalization projects

These four phases are often closely related to corporate strategy and linked to the guiding principle of a digital vision [14]. Both can be seen as superordinate. With regard to the four phases some generic disadvantages were identified for SME.

1. The determination of the initial situation with common analysis tools and methods is strongly dependent on evaluators' digital knowledge and experience with the evaluation method. Objectivity is a further cause of objection [2].
2. Most approaches lack a support of foresight methods and only refer to the assessors' intuition when it comes to the definition of desirable target picture.
3. Existing approaches either fail to hint on how to close the gap between initial and target situation or the methodology does not consider interdependencies and synergies in developing ways to close existing gaps.
4. Often a practicable tool to monitor the implementation, in particular of immaterial measures, is missing. By taking individual measures interdependencies and synergies between measures and future digitalization projects drop away.

Although some authors assume the digital strategy to be independent from digital maturity, the vast majority argues that there are some strong interrelations. Thus, it seems natural to involve digital maturity models into the development of digital strategies.

3 Research Approach

In order to address practical disadvantages in the development process of digital transformation strategies and to identify appropriate classes of maturity models to support this process, a multi-methodological research approach was carried out. In an initial literature review, current approaches for the development of digital transformation strategies

were analysed and examined for similarities and generic challenges. Results were discussed with representatives from 19 SME as part of the QuickCheck digitization [23]. In addition to the practice-oriented problems, requirements for maturity models in particular, were defined for the individual phases. These supplemented a cluster analyse of 38 digital maturity models. Finally, results were matched and clusters were assigned to the phases based on the requirements.

4 Incorporating Maturity Model into the Development of Digital Strategies

Many companies are struggling to develop comprehensive digital strategies, facing uncertainties, obstacles and generic challenges. The disadvantages described in Sect. 2.3 can be eliminated or mitigated by using maturity models. However, there are a number of digital maturity models with individual strengths and weaknesses [19]. These strengths and weaknesses need to be compared with the challenges of strategy development and used in a targeted manner. Accordingly, the individual models are suitable for different uses in the course of developing a digital strategy. For better understanding, clusters are formed, which can be illustrated in the model shown in Fig. 1. However, the derivation and cluster analysis should not be part of this paper. Instead, the three cluster categories are briefly explained in order to establish the relationship to the strategy development process.

In practice, maturity models are normally used to disclose as-is situation and target maturity levels. However, digital maturity models are also used to identify measures to close the gap to reach digital maturity and even to benchmark against competitors. In consequence, the following typically consecutive purposes of use are distinguished:

1. descriptive: The maturity model is used as a diagnostic tool to assess current capabilities of the functional area, department or enterprise under investigation and to assign maturity levels with respect to given criteria [16, 24].
2. prescriptive: The maturity model supports the identification of desirable maturity levels and derives concrete measures to close existing gaps between actual and target situation [16, 25].
3. comparative: The maturity model allows for internal as well as external benchmarking based on historical assessment data [24].

In addition to the field of application, the effort, i.e. the resources used in terms of time, personnel and capital, is decisive for the strategy development process in practice. For a rough classification, these are summarized in the category form of execution, bringing in the underling assessment method. Mix forms are in between.

1. Online self-assessment: Are suitable for a quick and resource-saving insight. Usually a single person answers a standardized online questionnaire addressing universal and predominantly technical aspects of digitalization.
2. Internal project: In a single day workshop, internal teams usually deal with the evaluation. Efficient processing requires a deep understanding of the capabilites to be assessed and the method itself.

3. External project: The assessment is carried out with the help of external consultants. In collaboration with internal teams, they assess the level of digital maturity within several workshops and interviews. This usually is the most costly form of execution also requiring high coordination efforts.

The remaining classification variable describes the object under investigation

1. Objects: Specific digital technologies, e.g. big data, block chain or cybersecurity, are qualitatively assessed from supply side or user perspective.
2. Division: Processes and structures of a single division are analysed for a specific topic, like Industry 4.0.
3. Enterprise: The digital maturity of an enterprise is assessed with regard to a desirable state of preparedness for digital transformation. Dimensions span from technology to culture and organizational criteria.
4. Sector: The influence of digitalization on a sector is assessed with regard to general statements from a supply side and user perspective.

Determination of Initial Situation
Digital maturity models provide a snapshot of the present level of digital maturity, representing the status quo within a company. Thus, they often serve as a starting point in the development of digital transformation strategies [18, 21]. However, a single person usually is not able to give detailed answers for all divisions. To build on a well-defined initial situation it is essential to assess processes, structures and socio-technological aspects in detail. Within several workshops and interviews a deep understanding of the as-is situation must be generated. This requires a high level of experience with the assessment methodology and a thorough understanding of the evaluation criteria [4]. Objectivity is also crucial. Many SME systematically overestimate their level of digitalization [2]. Therefore, the highest accuracy of evaluation and most comprehensive maturity models are suitable to determine the initial situation. An intensive cooperation with external experts is recommended.

Definition of Target Picture
Digital maturity usually is equated with digital readiness, which represents an enterprises state of preparedness for the digital transformation. The second dimension, representing the effect of digital transformation on the enterprise, is often neglected. Remane, et al. call this dimension digital impact [18]. However, both dimensions are crucial to define an enterprises target picture. In a first step, the digital vision is developed in accordance with corporate strategy. This is influenced by the digital impact, which results from customers and clients' expectations on the digitalization level and competitors level of digital maturity. For this purpose, a corresponding customer perspective should be taken in the qualitative assessment with maturity models. The focus is on the investigation of generalized and predominantly technological aspects of digitalization. However, it is crucial to involve clients and customers at an early stage. Intensive discussions between experts may sharpen the picture of competitor's maturity level. In addition, it can be helpful to get a picture of your own industry within a workshop and to assess its future

degree of digitization. Future potential and realistic target situations should be considered. To sharpen the own digital vision external benchmarks based on historical data are very helpful. Online self-assessments are usually suitable for this. It is recommended to discuss criteria internally, though.

Deduction of Digitalization Measures

Many SME do not dare to go beyond the previous step, because they fear to overlook essential aspects. Therefore, with a clear target position at hand, a detailed methodological approach to deduce measures to close the gap between initial and target situation is needed. Since this is a crucial step, specialist and methodological knowledge are required. Internal and external experts usually complement each other. Interrelations and synergies between technical and socio-technical criteria must be considered. Therefore, results should be brought together at divisional and enterprise level. Knowledge about previously unknown interdependencies is gained through an intensive and regular monitoring during the implementation phase. Attention should be paid, that the majority of existing maturity models neglects situational factors, such as structure, corporate culture or size, in order to reduce complexity [25]. However, these are crucial to systematically derive synergies, obstacles and interdependencies between digitalization measures and transformational strategies.

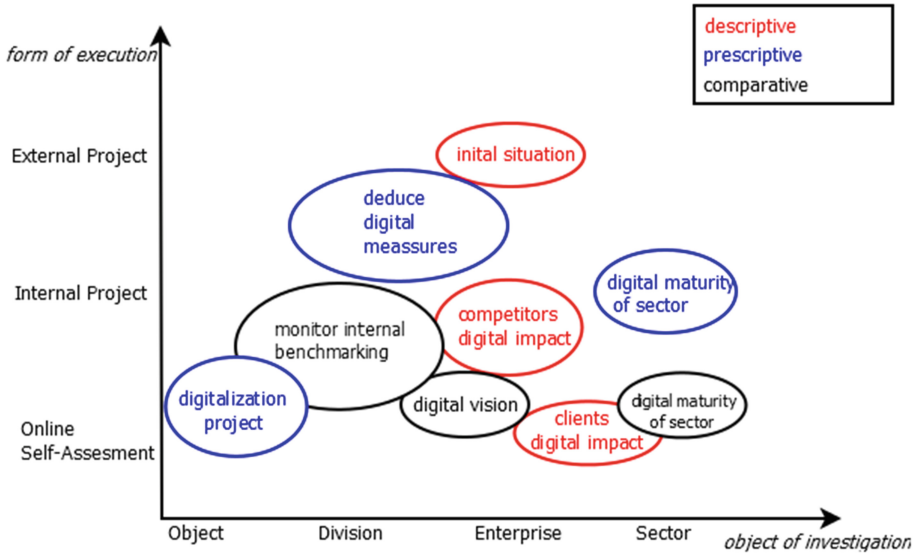

Fig. 1. Classification of the requirements for a maturity models in order to counter disadvantages of existing digital strategy approaches.

Implementation of Digitalization Projects

In order to get early indications of synergies and hurdles between the criteria when implementing measures, it is recommended to prepare implementation by evaluating the as-is and target level for the specific digitalization project. Beside the supply side

perspective taking on a user perspective is essential. Reassessing during implementation supports an agile implementation and early indication of socio-technical hurdles. Online self-assessments are suitable to gain quick and resource-saving insight. All digitalization projects must be monitored and regularly evaluated to identify unwittingly movements in maturity levels. Internal benchmarking across all digitalization projects direct the focus on urgent fields of action.

5 Conclusion

To reach a state of digital maturity, that enables an enterprise to achieve the desired transformation, plays an important role for the deduction of digital strategies. In particular, SME struggle to define a comprehensive digital strategy and a clear digital vision, facing uncertainties, obstacles and generic challenges. A growing number of practice-oriented digital maturity models, with a consecutive purpose of use, presents SME with the challenge of choosing the correct model to mitigate these generic disadvantages within the strategy development phases. Therefore, a classification of the requirements for digital maturity models is provided to support the selection process when incorporating digital maturity models into digital strategy. However, the validation of the classification and of the use within the four phases of digital strategies is still pending.

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Design and Development of Medical Devices

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Abstract. The medical device industry is one of the fastest growing industries. Medical devices cover a wide range of products for medical use, ranging from the simplest to the most sophisticated medical equipment. Thanks to today's rapid development in both medicine and technology, the development of medical devices has been intensified. Given the multidisciplinary characteristics of such devices and their environment, the process of developing medical devices involves some special characteristics. Due to their potentially harmful effects in the interaction with tissues and organs, compliance with the various directives is of particular importance. For these reasons, it is necessary to carefully follow all steps in the design and manufacture of medical devices in order to obtain regulatory approval and licensing of the products, so that their implementation is safe for users. This paper demonstrates that medical device design is a unique and complex process which requires an organized development strategy that ensures that the product meets design and user goals, is technically reliable, and can be produced safely and efficiently.

Keywords: Medical device · Design process · Design methodology · Product development · Directives

1 Introduction

Thanks to today's rapid development in both medicine and technology, the development of medical devices has been intensified. The medical device is a term used for a large variety of products for medical application, going from the simplest to the most sophisticated medical equipment. As the functionality of the device becomes more complicated, problems related to reliability, efficiency and safety appear [1]. Given the multidisciplinary characteristics of such devices, as well as their potentially harmful effects in the interaction with tissues and organs, it is of great importance to harmonize their development process with various directives. Many studies have shown that the application of design methods in the design of medical devices and their development can achieve significant improvements [1–3]. Pietzsch et al. presented the linear stage-gate model that gave a comprehensive description of various activities and decisions related to the development of medical devices [2].

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 40–47, 2022.
http://doi.org/10.1007/978-3-030-97947-8_6

Medical devices are important parts to improve patient overall safety, so it is necessary to know the way they are designed and developed. Tamsin et al. analyzed important factors such as: product development, tissue modelling, training, and FDA regulations, which must be considered during the design process [3].

Scientific and technological development has made it possible to achieve the design of medical devices that will not be only functional, but also modern and advanced. Barrios-Muriel et al. gave an overview of various rapid prototyping applied in the orthoprosthetic industry and pointed out that the choice of material in the design of an orthotic device is crucial for its success [4]. High-tech development has enabled the research of substances at the molecular level, which has encouraged the design and development of nanostructured materials that offer outstanding properties for use in medicine [5], prostheses and bone replacement implants. The application of these new nanomaterials in bio-medicine has led to the emergence of a hybrid science called nanobiotechnology [6]. Ramos et al. gave an overview of the use of new materials (nanoparticles) for specific medical applications in [7].

2 Regulatory Framework for Medical Devices

In recent decades, medicine and technology have been strongly linked. Nowadays, one of the most important tasks is the development and improvement of devices used in medicine, not only for better medical practice, but also for better understanding of human bodies. For these reasons, it is necessary to carefully and thoroughly perform all steps in the design and manufacture of medical devices in order to obtain regulatory approvals and licensing of products so that their application is safe for users.

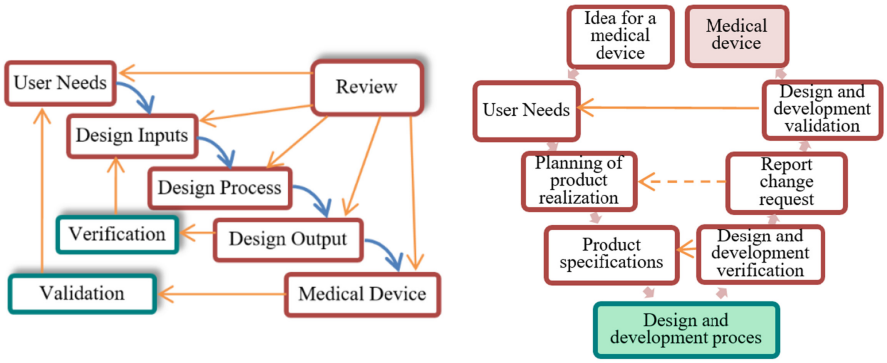
There are many different organizations around the world that are responsible for regulating the activities of companies that manufacture medical devices. In the European Union, the Medical Devices Directives are in force, while in the USA, they follow the regulations of the Food and Drug Administration [8]. There is a common regulation for the members of The Global Harmonization Task Force (GHTF), whose members are: Australia, Canada, the European Union, Japan and the United States. In Serbia, the Medicines and Medical Devices Agency is responsible for regulatory affairs. According to The Global Harmonization Task Force, a medical device is any instrument, apparatus, machine, appliance, implant, etc. intended by the manufacturer to be used in the diagnosis, prevention, monitoring, treatment or alleviation of disease or other condition [9].

3 Medical Device Product Design and Development

Product development refers to the realization of market demands or a new idea into a new product [10]. Within the product development, a creative phase takes place which is related to product design. The design includes the selection and analysis of relevant data and factors in order to innovate the product, optimize its functions and improve quality. When it comes to the design and development of medical devices, the main goal is to provide a more efficient solution for products for medical use in order to improve and save human lives. In order to meet the requirements for good design, it is necessary

to apply a methodology that systematizes research and directs the process towards the right solution [11].

As indicated in the previous chapter, to be compliant to regulations medical devices, must go through rigorous testing, validation and verification processes, which is specific to medical industrial design and production quality control standards. Verification and validation are checks in the design process that identify flaws and deviations in the design before the medical device is produced. Verification is a detailed review of design aspects at different stages of medical device development and provides an answer to the question of whether a product is correctly designed. Validation ensures that the correct product is designed to meet the needs of users [12].



(a) (b)

Fig. 1. Product design and development models: (a) Waterfall model and (b) V-model.

Verification and validation prove that the medical device is safe, effective and meets the needs of end-users and patients. The importance of these activities in the design process of medical devices is illustrated by the example of the traditional waterfall model, shown in Fig. 1a [8]. The design inputs phase involves developing an idea and collecting data to define conditions that the product should satisfy. These conditions (requirements and wishes) are the result of the current needs of the market, users and production capabilities. During the creative phase, requirements are developed and a device is designed that will meet these demands. The design is then tested and evaluated to produce a device that meets customer and market requirements and is optimized for production.

In addition to the waterfall model, validation is also presented in the literature as a product development V-model [13]. V-shaped model, shown in Fig. 1b is an expansion of classic waterfall model and it's based on associated test stage (the right side of the V) for the every development stage (the left side of the V). This model due to the equal number of testing and development is referred to as the verification and validation model. This is a very strict model and the next stage is started only after the previous one is completed.

The main difference between the waterfall model and the V-model is that in the waterfall model the activity tests are performed after the completion of the development activities, while in the V-model, the testing starts from the first phase. While the tests are just one of the steps in the waterfall, it seems to be practically half the process in the V-model. Basically, both models follow the same steps only they are presented in different ways.

4 Design Factors of Medical Devices

In the process of product development in order to achieve high quality, the designer must consider a large number of different influencing factors such as function, purpose, material, colour, texture, etc. In order to design a product that will fully meet the requirements of users and be competitive in the market, it is necessary to define in more detail which functions are vital for the successful operation of the device, and which are the secondary functions. Also, designers must be acquainted in detail not only with what the product should do, but also where it will probably be used (e.g. in a home, hospital, or operating room) and who will use it (e.g. children or adults). The realization of the function and purpose includes many variations of appearance, design and materials used. One of the most effective methods for improving the performance of medical devices is to replace the metal with ceramic or plastic, as shown in Fig. 2. By applying high-performance biocompatible polymers, with simple design modifications, cost savings, improved aesthetics and ergonomic improvements are achieved. One of the advantages of using plastic is the possibility of painting products of different sizes (colour coding), which can be easily and quickly recognized in the operating room.

Fig. 2. Material as a medical design factor: (a) cup – metal or polyethylene, (b) liner – ceramic or polyethylene, (c) head – ceramic or metal, (d) femoral stem – cement less or cement and (e) hip prosthesis (adapted from [14]).

Colour is a very important element in the design of both industrial and medical devices because the use of colours can achieve very different effects. In addition to improving the aesthetic appearance of the product and emotional - psychological effects, colour can draw users' attention to certain elements of the product and provide them with information about their functions and characteristics, as well as the possible danger. Also, the parts that are threatened by some danger should be specially painted with colours that are easily noticeable and that excite the human psyche and have a strong effect on it (red, orange, yellow, etc.). One of the most important applications of colour in the design of medical devices is colour coding [15].

When choosing a colour, surface treatment should be taken into account, which can significantly affect the perception of colour. The texture may occur as a result of processing or are deliberately formed as a functional or in order to improve the aesthetic appearance of the product. When designing products for use in the operating room and other environments with high lighting, one should keep in mind the fact that white reflects the most light, causing glare and eye fatigue. Giving white surfaces a matte finish will alleviate these problems to some extent. In addition to visual perception, tactile texture sensation is important in medical devices.

(a) (b)

Fig. 3. The texture of medical devices: (a) trigger for open-surgery device and (b) trigger for laparoscopic-surgery device [16].

For example, while the trigger of an open surgery device is rubberized and textured on the inner edge and part of the outer edge for flexible control, the lower outer edge has become extremely smooth without the use of rubber, as shown on Fig. 3a. This design was chosen after confirming that the rubberized trigger surface can inadvertently catch the surgical curtains and interfere with the operation. For a laparoscopic surgery device, the entire outer edge of the trigger is non-rubberized, as shown on Fig. 3b, because of the greater possibility of it coming into contact with surgical drapes in such operations [16].

The texture of medical devices can affect how easily the product can be cleaned and disinfected. Fingerprints and stains are easily seen on shiny surfaces, but too rough a texture allows for easier surface contamination.

5 The Example of the Designs of Custom Made Hip Prosthesis

Using the artificial hip joint instead of natural hip joint and establishment of the patient's lower limb function become very often procedures in orthopaedic surgery. According to research, more than 500,000 procedures of this type are performed every year in the US and UK alone [17]. There is a significant increase in the number of diseases whose treatment needs replacement of the hip joint with an artificial.

The improvements in the hip endoprostheses' characteristics can be obtained by using a personalised design approach, computer-supported analyses in order to optimise the characteristics and production. Recent research shows that the custom-made endoprostheses allow significantly improved implants fittings to the bone [18] and biomechanical characteristics [19] as well as significantly lower failure occurrences [20].

Researches from the University of Novi Sad [21] presented the original methodology of designing the hip joint prosthesis according to the patient's measurements. It is based on the assumptions that it is suitable to apply a general geometric model based on the mathematical description of the outer surface of the endoprosthesis.

The development of hip joint endoprostheses using computer support in methodology way includes a systematic access to defining geometric parameters which are classified according to the importance regarding the prosthesis shape and its function. The methodology of custom design of hip joint is based on the application of three groups of parameters for the geometry of the endoprosthesis body. According to the purpose and stage in which they are used, the parameters can be classified by their effect on the location, overall dimensions, orientation and the endoprosthesis shape (Fig. 4).

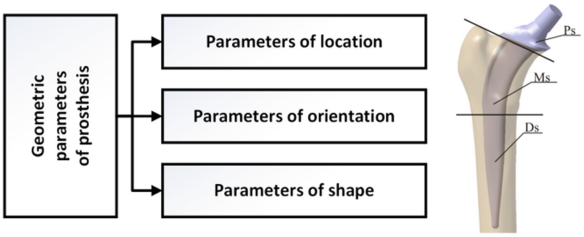
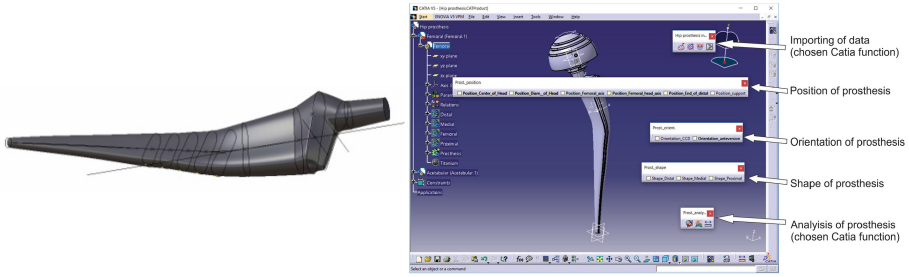


Fig. 4. Parameters of the endoprosthesis [21].

Developed software was used for designing of the hip joint endoprosthesis body. It allows the design of the endoprosthesis body and the selection of the acetabular component. The entire femoral part of the endoprosthesis was obtained by forming a common multi-sections surface containing the said profiles guided by the resulting curve attained by the integration of the partial guiding curves. The surface thus obtained is added to the proximal part of the femur model which is defined by the surface forms, determined by the standard of the bond between the artificial head of the femur and the body of endoprosthesis, as well as additional shapes conditioned by the requirements of the technology of manufacturing and assembly into the body (Fig. 5).



(a) (b)

Fig. 5. Design software implementation: (a) graphical definition of endoprosthesis body and (b) graphical interface of the developed software [21].

6 Conclusion

The development of medical devices is a complex activity based on market demands, where compromises must be made regarding factors such as product innovation, regulatory risk, application of new technologies and production opportunities. Therefore, it is essential that medical device manufacturers consider all influencing factors and apply the most efficient methodology. This paper presents some of the models that are applicable for improving the design and development of a medical product. The need for verification and validation in the medical device design process in order to obtain device approval was emphasized. From the presented review it can be concluded that user requirements must be entered correctly at the beginning of the product development process. Also, consideration of all regulatory aspects should be included in the early design phase. This study highlighted the main factors to consider when designing medical devices.

The process of designing and fabrication of medical devices has been a very interesting research area which still attracts considerable engineering activities. The main reasons for such interest are the complexity of biomechanical conditions, the influencing factors on the operation success and medical devices lifetime, as well as the cost-effectiveness of their production.

The basic advantage of the described methodology of custom made endoprostheses is the formalisation of all stages of the development and production of custom made implants. Additionally, defining the parameters of the endoprosthesis geometry and their association with bone morphology creates possibilities for partial or complete application of the methodology, depending on the available methods of the diseased femur imaging technique. There is a significant area left for its expansion with new parameters and criteria. Also, despite significantly higher prices, research indicates an increase in the need for patient-specific endoprostheses, primarily in the revision and reconstructive procedures. The number of such procedures indicates the market existence, whose growth prospects may influence primary endoprosthesis market as well.

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Shaping the Future of Serbia's Economy: Impact of the Industry 4.0 Platform on Industrial Output

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Abstract. Recently, the Covid-19 pandemic has hit the world economy as a meteor impact, provoking a truly systemic effect. It pushed the economy into pause, additionally downgrading risk appetite by persistently weakening demand, supply, employment, capital investments, and all forms of discrete investments (education, science, R&D, health care, etc.). Making a sustainable and inclusive growth pattern is not possible without the paradigm change both in microeconomics (technology (like Industry 4.0 model) and business model) and macroeconomics (resource and energy circulated model of growth and heterodox economic policy platform, including also Industry 4.0 Platform). The objective of this paper is to fill the present conceptual vacuum in economics with the aim to identify catalytic strategies for transition of growth model based on financialization and linear manufacturing into the resource and energy circulated model of growth and heterodox economic policy platform. Intention is to highlight insights about the macroeconomic specifics of Serbia and potentials of Industry 4.0 platform from engineering perspective as a way of sustainable and inclusive growth through new industrialization. Industry 4.0 is an opportunity for any post-Covid 19 macroeconomic scenario.

Keywords: Industry 4.0 · Circular economy · Economic policy · Manufacturing sector

1 Introduction Remarks

In today's rapidly changing industrialized world, globalization, customer-oriented products and advanced automation, play a major role in the development of high-tech manufacturers. This industry is at the forefront of the application of Industry 4.0 solutions, bringing cutting edge technologies that will change the products, processes and supply chains [1]. Industry 4.0 introduces even greater connectivity through IC technologies, enabling manufacturers to maintain their competitive advantage in a rapidly changing world, and to respond flexibly and quickly to customer demands. Industry 4.0 in the manufacturing sector, plays a key role in three areas [2]: (a) smart supply chains, (b) smart

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 48–55, 2022.
http://doi.org/10.1007/978-3-030-97947-8_7

manufacturing, and (c) smart products. In Serbia, since 2006, the Faculty of Mechanical Engineering in Belgrade has been working several projects related to various EU initiatives and programs, which were related to new technologies and their application in research and practice [3–5]: Manufuture program, Intelligent Manufacturing - World Technology Forum - WMF, and Factories of the Future - FoF. We are started working on the Industry 4.0 Program in Serbia at the Faculty of Mechanical Engineering in Belgrade in June 2015. Since 2016, the Conference - Advanced Manufacturing Program - Industry 4.0 model for Serbia has been held in Belgrade every year. Since the first AMP Conference, the Faculty of Mechanical Engineering in Belgrade has organized twenty-five Panels on Industry 4.0, where, among other things, the following topics were discussed: New Industrial Policy of Serbia, Education of Mechanical Engineers for Industry 4.0, Industry Model 4.0 for SMEs, Programs Industry 4.0 in the world, Industry 4.0 for the defense industry of Serbia, and others. In this way, the Faculty of Mechanical Engineering in Belgrade became the leading national educational and scientific institution for the Industry 4.0 model in Serbia and the region WBC [3–7].

The main goal of the paper is to present the economic policy framework for Industry 4.0 in our country, as well as to provide elements of the Industry 4.0 Platform for Serbia.

2 Serbia: From Industrialization to Deindustrialization and Back

Industrialization in Serbia intensified in early 1960s based primarily on technology transfer in tradable sectors, sectors that export and/or compete with imports based on comparative advantage. Despite export expansion, current account deficits ware a consequence of technology purchase and terms of trade. Deficit in capital balance was a result of credit financing of related technology purchase. So, double macro deficits increased debt burden and decreased speed of growth, Consequently, Serbia entered in "middle income trap" in the middle of 1980s [8, 9].

Fiscal balance was a prerequisite for dynamic economic growth, along with structural changes. At the end of 2019, the government has prepared a new industrialization programme with the special focus on implementation of the Industry 4.0 platform. Unfortunately, the Covid-19 pandemic postponed the implementation of this programme. After a positive growth rate of 5% in 1Q 2020 as an echo effect of previous growth inertia, industrial production plunged in 2Q 2020 by - 6%, primarily as a result of lockdown. Negative shocks from both the supply and demand side elicit a deeper decline and longer recovery [9].

3 The Covid-19 Crisis and Anti-crisis Programme

The New Normal is a combined crisis, an economic crisis within a medical crisis. Under the impact of the New Normal we are not living in transformation age, but rather in a transformation of an age. Social distancing as key medical measure has push economy in sleeping mode. Core macroeconomics policies responses include liquidity infusion and fiscal stimulus, both in massive and permanent way. Such policies will destroy the market place and increase moral hazard.

Figure 1 portrays alternative post-Covid-19 pandemic economic trajectories as results of medical and macroeconomic responses to the crisis. There are four alternative scenarios: L-shaped, swoosh-shaped, V-shaped, and W-shaped. The extreme scenarios from the previous figure are a V-shaped recovery and L-shaped recovery. The best-case recovery, or a V-shaped recovery, is a consequence of an adequate macroeconomic (monetary and fiscal) response and an adequate medical response. Unfortunately, today nobody talks about V-shaped recovery. The worst-case scenario, or L-shaped recover, assumes no monetary and fiscal responses to supply and demand shocks and no medical response.

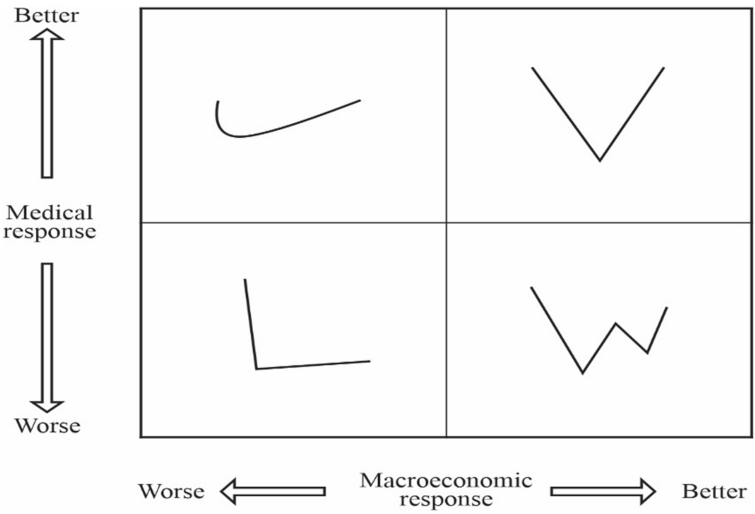

Fig. 1. Alternative post-Covid-19 scenarios.

The combined scenarios are swoosh-shaped and W-shaped. In a swoosh-shaped scenario, we actually have a slow rebound without restructuring. W-shaped scenario is a consequence of inadequate medical response to the successive waves of the pandemic, leading to double-dip crisis. In a combined crisis without an anti-crisis programme, the economy could not survive. To avoid being in freefall, every government in the world performs anti-crisis program. In this programme care measures must be taken to ensure that short-term solutions for both aspects of crisis do not create long-lasting problems. The content of an anti-crisis programme comes with the type of the crisis (medical crisis in economic crisis). Consequently, according to [10, pp. 1–25], the purpose of an anti-crisis programme is twofold. First, the flattening of the epidemic curve as much as possible with the aim to save human lives and avoid medical system overload with infected patients. Second, steepening the recession output, explained by J-shaped curve, with the aim to prevent an economic free fall, L-shaped recovery or swoosh-shaped recovery. Dotted lines from Fig. 2 portray trend lines without anti-crisis programme, in medical crisis and economic crisis.

In the anti-crisis programme many things have happened from the unconventional side of economic policies. In the monetary sphere, massive liquidity pumping through bailout of creditors and quantitative easing (QE) are new variations of the role of the central bank as a "lender of last resort". A balance sheet expansion and emergency purchase of state and corporate bonds, explains that the central bank is going to be a "buyer of last resort". Also, along with QE aimed at making liquidity infusion in financial intermediaries (or the Wall Street), central banks also provide financial support to the real economy (the Main Street). Moreover, the permanent stimulus is a constant of fiscal policies.

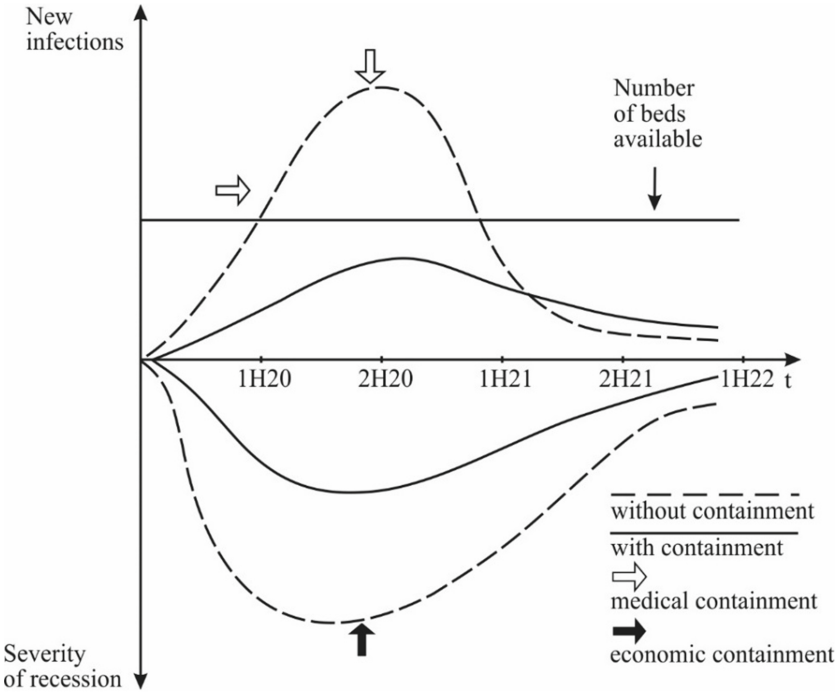

Fig. 2. Two simultaneous processes of an anti-crisis programme. Source: Partially modified from [10, p. 9]

It is premature to say that the turning point from downfall to recovery happened. For the strategic inflection point to occur, a strategy of new industrialization is required. Following a successful recovery, for a sustainable and inclusive growth pattern, the new growth model and related policy platform is needed.

4 New Growth Model and Economic Policy Platform

Reindustrialization as a road to long-term recovery is not possible until the economy remains in lockdown. The successive waves of infection triggered by virus mutation are increasing fears and the economy is not getting back to normal quickly enough. Without any doubt, the neoliberal model of growth based on market fundamentalism and inflation targeting has caused deindustrialization, massive economic unbalances and social and environmental harm to a level that threatens the continuation of the economy and the planet Earth, as a whole. The Covid-19 pandemic only exacerbates deeply rooted structural imbalances. To mitigate the complex crisis like this one, the government should take radical reform steps to make conceptually complex economic model through implementation of the "visible hand" of the state (structural, intentional or industrial policies) along with the "invisible hand" of the market. The necessity of redirecting cash flow from speculative investment to impact investment, or investment with high negative external effects, is evident all round the world. The greater part of impact investment will be in carbon-free technologies, infrastructure (physical and digital), science, education, and health care. So, the government thinks about core policies (monetary and fiscal) on structural way. To implement resource and energy circulated economy model of growth, the economy must follow a set of goals defined by the United Nations and known as Social Development Goals [11]. Government internalizing externalities is essential for impact investment in infrastructure. With industrial policies the government will accelerate technological change with the aim to break the deindustrialization stalemate in implementation of frontier technologies. The previous is the well recognized the issue in the EU and a prerequisite for transcending current linear industrial model in circular one [12]. In the long-run, the road map for rapid decarbonisation and medical system adjustments for microbe mutations will be promising pathways toward a new industrialization based on circular and greener economy. One way of framing up the new context is implementation of the new framework.

Fast rebound is not possible without radical transformation of the economy. High-tech manufacturing based on combinatorial innovations has an important role to play in transformation toward industrial production of the future. For the first time in history of humanity universal connectivity is a free good. We can live simultaneously in physical reality and virtual reality. Roadmap for transformation of linear manufacturing sector in Serbia is Industry 4.0 platform with the aim to develop cyber-physical production systems able to produce intelligent products. It is way to increase share of industrial production in output formation from current 23% to expected 30–40% in the long term. Advanced industrial production based on Industry 4.0 solutions enable us to manufacture products at practically near zero marginal costs and small amounts (means high diversification). Moreover, the nature of advanced industrial production is more conducive to social distancing and contingent operations.

Moreover, previous catalytic strategy will contribute to return to pre-Covid-19 level of output sooner. Conventional manufacturing sectors, for example cars, energy, aerospace, could not contribute to rebound significantly. They desperately need right-sizing (capital, assets, and number of employees), transformation toward carbon-free industries and diversification (medical equipment, primarily).

Service sectors of the economy (hotels and resorts, air transport, retail and wholesale, business services, financial services, etc.), in which it is more difficult to practice work at home, plunge into lower recovery due to deepening downturns.

On the global level, paradigm shifts toward the circular model of growth and a heterodox economic policy platform require immense investments (from billion to trillion). The question is: How can we finance new industrialization and how can we get capital that is needed? The ideal source of financing of the circular and greener economy is long-term bond issuance with over-proportional yield. The so-called "green bond" is necessary for attracting more savings. Also, pensions and life-long insurance are important sources of finance. Theoretically, there is no limit to money (and credit) expansion. Consequentially, the so-called "green credits" as a supplementary credit channel for carbon-free industrialization and enhanced medical security could be used to energize economic development. Actually, it is intentional variation of "QE" (quantitative easing), but this time it is a "green QE". Simplifying to extreme, it is money printing for impact investments. Also, digital money could be used in a parallel way through centralised (instead of decentralized) channels with existing transmission channels. Better quantification of related risks of environmental and health care degradation led central monetary power to stress-test commercial banks along criteria such as contribution to climate and medical crisis mitigation when they released "green credits".

In tax policy, along with income tax, value-added tax, and digital tax, all on global level, innovative solutions are "carbon tax" and "medical tax". Every country has its own way toward a more sustainable and inclusive growth pattern regarding the people and the nature. There is no automatic pilot. In case of Serbia, promising industries based on the Industry 4.0 platform are as follows: ICT, confectionary and dairy based on organic agriculture, renewable energy, pharmaceutical and medical equipment. In service sector, health tourism has a great potentials. Transcending toward new industry requires implementation of Industry 4.0 platform as catalytic strategy of change. Industry 4.0 is related with disruptive innovations. In case of non-essential products, demand disruption, along with business model disruption, the new business development is required. In case of essential industrial products, business model change and structural portfolio restructuring are feasible options.

A relief and stimulus programme should be designed to steer manufacturers to energize production, employ people, and reward value creation instead of stimulating speculative investments on capital markets. Structural (or industrial) policy measures should encourage investment in sustainable growth along with reduction of the carbon footprint and medical security.

5 Digital Platform of Serbia for Industry 4.0

The Digital Platform of Serbia for Industry 4.0 (hereinafter - the Platform) is a unique vision of connecting all industrial sectors, using ICT, for their digital transformation, with the basic goal of raising the competitiveness of Serbian industry in the global market. It connects industry, educational, research institutions, decision makers and NGOs on common goals of digital industry transformation. The Platform is part of the Industrial Policy of Serbia 2020/2030. The Platform enables our country to join the club of 37 most

industrialized countries in the world, which have and doing according to the Strategic national program for Industry 4.0. The platform is a National Strategic Initiative of the Faculty of Mechanical Engineering in Belgrade as a representative of the Alliance I4.0 Serbia, the Ministry of Economy and the Serbian Chamber of Commerce. The political levers of the Platform include the initial design phase, the visionary and top-down management role of the Ministry of Economy and the Serbian Chamber of Commerce in the form of developing a strategy for the application of this concept in practice. Expected results include: acceleration of innovations, realization of industrial solutions for I4.0 in practice, new generation of trained and highly qualified professionals and development of sustainable and competitive industrial ecosystem in Serbia. The main goals of the platform are: (1) increase of contribution of industrial production in GDP of 23% to more 30% by 2030; (2) increase investment in research and development from the current 0.6% to 1.5% of GDP by 2030; (3) increasing the innovation potential and exports of domestic companies, and on the basis of high added value-added products (intelligent products); (4) reduction in blue-collar work; and (5) increasing the application of digital technologies in industrial production. The Platform has the following parts: (a) Education and training for I4.0; (b) Manufacturing in value chains - intelligent products; (c) IC Technologies in Industry 4.0; (d) Industry 4.0 Cyber-Physical Pilot System/Center of Excellence for Mechanical Engineering and (e) Innovation and eco business models for industry. The Platform represent an integral Strategic vision of the advanced industrialization of Serbia. The main role of the Platform is to generate recommendations and facts for the Policy of the Government of the Republic of Serbia in the field of economic and industrial development for the period 2020/2030.

6 Conclusion

The digital platform is a roadmap for the transformation of Serbia's manufacturers, especially for the improvement of the competitive position of established businesses and development of SMEs. The basic framework for this is Cyber-Physical Systems (CPS), which should produce intelligent products. Industry 4.0 requires a philosophical change in the establishment of new production facilities and leads to a new vision of production based on new paradigms: intelligent production and products, and communication and information networks as intelligent software [13] presents a scenario for the transformation towards Industry 4.0, at the level of national policies and programs.

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Integration of Game-Based Software Tools into Higher Education

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Abstract. Technology is increasingly being used in all areas and is greatly involved in modern education. This paper aims to examine the impact of using game-based software tools on student engagement and motivation during class. The goal of using game-based software tools is not to replace the work of teachers, but to support the active involvement of students in the topics currently under study. The results of previous research on the use of a game-based software tool and the results obtained using the same tool in an online learning environment are compared.

Keywords: Game-based technology · Software tools · Higher education

1 Introduction

The rapid increase in the availability and accessibility of interactive technologies has contributed to the adoption of games in science and higher education to encourage learning and research. Students can experiment with different technologies to support their learning, and that is the reason why they enjoy using mobile and web applications [1].

According to research on the dynamics of attention span during class, students' attention is increased during the first ten minutes of the class, and it decreases after that. One way to solve this problem and get students' attention is to change the environment during class [2]. Another way is to incorporate game-based software that helps the stimulation of dopamine, which plays a key role in student motivation, influence, and learning. Game-based student response systems (GSRS) should increase students' engagement. In universities, maintaining students' attention and engagement in information technology classes can be difficult, as teaching is often teacher-centered, with limited student involvement and interaction between them. Lectures become monotonous, and students tend to engage in non-task related activities [3]. It is expected that integrating game-based software tools in teaching with the purpose of testing knowledge and repeating study material will increase their engagement and learning. Under the social norms prescribed by the lecture environment, students rarely ask public questions and prefer to remain anonymous [3], thereby reducing student engagement. However, the use of game-based

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 56–63, 2022.
http://doi.org/10.1007/978-3-030-97947-8_8

software tools allows students to remain anonymous while interacting with the teacher and other students [4].

The use of gamification in education enhances student response systems (SRS), with promising results [4]. SRS is often used to screen multiple-choice questions to offer students the ability to interactively respond to quizzes as part of a formal grading regime. There is a noticeable difference between student response systems such as iClicker and Poll Everywhere and more modern student response systems such as Kahoot! [5]. The use of GSRS in the form of gamification requires participants to activate prior knowledge and evaluate their reactions while playing and learning. GSRS should increase student attention, motivation, engagement, and enjoyment beyond traditional methods. In this way, GSRS systems should overall improve teaching, but also at the individual level should motivate students who do not normally participate in discussions, and GSRS systems are useful teaching tools in fostering learning personalization [4]. Based on these assumptions, this paper will present the results of an exploration of the use of a GSRS tool in teaching at the Faculty of Technical Sciences, University of Novi Sad, Serbia.

Kahoot!, as a game-based learning platform, is a free tool used in various fields. This platform has more than 30 million users worldwide [6]. Kahoot! was created in 2015. by Jamie Brooker and Johan Brand as a system that allows users to create different types of games, such as quizzes, polls, and discussions in which participants compete against each other. It is a system that can work at a classroom level, and the idea is that more students or even the whole class should participate. Kahoot! supports assessments, productive formative assessments, and student reflection [7]. In the beginning, the teacher registers on this system, and afterward, he can select a large number of predefined games that can be easily adapted to his needs or can even create his own game entirely. The creation process is straightforward and easy. After that, students participate in a competition based on the created game, at the same time, each on their device. During the game, the best and fastest answers to each question are revealed, as well as the overall results at the end of the session [8].

This paper aims to investigate the impact of a tool based on the game Kahoot! on the activity, motivation, and learning of students in the online learning environment and to compare the obtained results with previous research [9] conducted in the laboratory environment. A survey was used as a research method and the obtained results are presented in this paper.

The remainder of the paper is organized as follows. Section 2 presents background and related work in this field. Section 3 describes the methodology used in the research. Section 4 the obtained results are presented and compared with the previous research [9]. and Sect. 5 concludes the paper and suggests future research.

2 Background and Related Work

Dominiques et al. [10] used an e-learning platform to find out how the use of gamification influences students' motivation to participate actively in teaching. A special software add-on has been created for the platform used in the course as an introduction to information and communication technologies, and this add-on allows the use of

game elements such as trophies and medals, which students receive after completing a specific assignment. Qualitative analysis of the results revealed that gamification has a great emotional and social impact on students, both because of the reward system and the competition part because students were immediately ranked according to the results obtained and could be seen by all, thus knowing their progress in relation to others. However, such results were not shown for all students. Some students did not find it amusing to compete with classmates and did not like the fact that everyone could see their results.

On the other hand, the quantitative analysis shows that the cognitive impact of gamification on students has not proved very significant. Students who participated in the research performed better on practical assignments than on written ones, compared to those who took the course regularly. Also, at first, they had great motivation to actively participate in teaching, but it decreased over time.

Giannetto et al. [11] tried to reduce the motivation problem by using the QizBox web application in teaching. They designed a reward system based on experience points, where participants can complete one of 5 roles based on their engagement in teaching. These roles are Social, Smart, Researcher, Mentor, and Diligent. Particularly interesting is the role of the Mentor, which students get when they help their classmates with specific difficulties by answering questions in a community forum and encouraging their work. For each role, students receive a corresponding trophy and are thus encouraged to advance to the next level of the role. This paper did not evaluate the results, only set up an implementation framework.

Song et al. [12] wanted to show whether learning object-oriented programming is more effective through the use of play. They claim that good game design is key to maintaining the fundamental goal of gamification, which is learning. The user interface is very important to keep students' attention, so it must be clear and straightforward. It is essential to have a good story in the game to keep the user occupied and interested in what is next. In this case, the game Ztech de Object - Oriented is used, in which the story of object-oriented concepts extends throughout the levels. The main player in the game is a student, which is why this is a role play, where the character is being upgraded to the highest level. The results of the survey, where the students expressed their opinion about the game, show that this way of learning is better than the traditional ones, but they think that a better reward system should be introduced.

In order to engage students and enable them to learn programming actively, Mathrani et al. [13] used the educational LightBot game. In this game, players are tasked with controlling a robot that needs to light up all the blue tiles in the walking area, and they do this with a set of commands that represent basic programming concepts. The game has four stages, and each stage has six levels with a gradual increase in weight. The survey itself was applied to two groups of students, the first of whom had no programming knowledge, while the second had recently completed one programming course. The results show that students of both groups enjoyed the game and felt that through the game, some concepts of programming - functions, procedures, conditions - were mastered more effectively. With the students of the first group, this game created a positive attitude about learning programming, but some thought it would be better if they first completed a traditional programming course and then only played the game. The

students of the second group achieved better results in the past phases but also stated that they would prefer to have various tasks. Overall responses indicated that the first group had shown greater enthusiasm than the second group. This consequence was explained by stating that the students of the second group were already familiar with these concepts and that they were preoccupied with the obligations in other courses. This conclusion provides room for further consideration.

Based on this research, it is assumed that game-based software tools help students learn. Therefore, further in the course of this paper, the results obtained in a student-led survey on the impact of a game-based software tool - Kahoot! to student learning in higher education.

3 Methodology

This research aimed to examine the satisfaction and impact of using software tools – Kahoot! to students who used it in teaching based on the following research questions:

RQ(1): Does Kahoot! influence student motivation?
RQ(2): To what extent does Kahoot! affect student engagement and learning?
RQ(3): Have students accepted the use of game-based software tools in learning?
RQ(4): Does Kahoot! have a better impact on the online learning environment?

An electronic survey was conducted through December 2019–January 2020 at the end of the first semester on students using Kahoot! during class, and the results are presented in [9]. The extended electronic survey was conducted once again in June 2020 at the end of the second semester. Compared to the previous research [9], Kahoot! was used exclusively in an online learning environment. The reason is that in the second semester, all forms of lectures were performed remotely, because of the Covid19. Previous research shows that students easily accept the online learning environment [14]. The goal of this paper is to test if Kahoot! is more accepted in the online learning environment. The survey consisted of ten questions, where the first two questions classified students based on their gender and study year. The remaining eight questions regarded the impact of the Kahoot! tool in their work, engagement, motivation, and learning. Participants in the survey were students of the Faculty of Technical Sciences who used a game-based software tool – Kahoot!. This tool is used in such a way that teachers prepared questions for students and used them to repeat the material during class, while students answered questions and competed among themselves. At the end of the semester, students who were involved in the courses in which Kahoot! has been used, completed the survey. A total of 184 responses was collected.

4 Results and Discussion

The obtained results show that the respondents are students coming from different study years of Information System Engineering [15] at the Faculty of Technical Sciences. The learning environment for students in this field is very important and is constantly working to improve the learning experience in laboratories and the online learning environment

[15]. Most of the respondents are in the second year of study (35%), the first year (26%), third-year students (14%), students fourth year (18%), and minority are from master studies (7%). All respondents used Kahoot! during classes (Fig. 1).

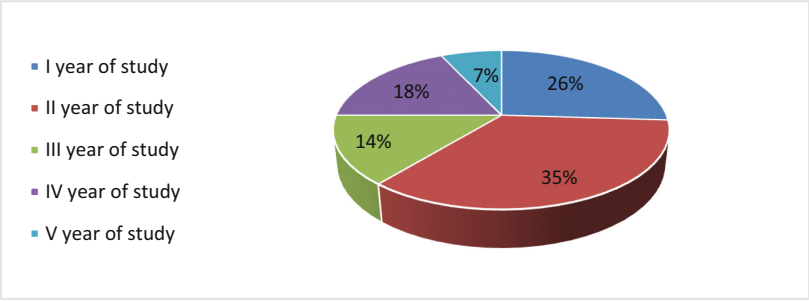

Fig. 1. Demographic characteristics of the respondents by the year of study (source: author's survey)

The first thing investigated among the respondents was if Kahoot! helped them to repeat the coursework. Most of the respondents answered that the use of Kahoot! helped them to repeat the material (92.2%), while far fewer (5.5%) expressed that Kahoot! did not facilitate the repetition of the material during the course. The rest of the respondents did not express their position on this issue.

Next, the question of interest is the extent to which students consider Kahoot! encouraged them in active involvement in teaching. Most respondents said that they felt that using such a tool encouraged them to be actively involved in teaching (91.9%). The rest of the respondents said they generally disagreed with the fact that Kahoot! had an impact on their involvement in teaching. These student responses agree with the assumption that the inclusion of GSRS tools in teaching encourages the active involvement of students in teaching and the topic currently addressed [4].

The concept of this tool also involves competition between the students when it comes to answering the questions posed by the teacher, fostered positive competition, and whether it affected their learning motivation. Most of the students answered that the use of Kahoot! tools encouraged positive competition (87.4%), while the rest of the respondents did not express their views on this issue. When it comes to assessing the influence of this tool and the competition between students on their motivation, the respondents in the majority estimate that Kahoot! positively influenced their motivation (89.7%), while the rest of the students (10.3%) expressed their disagreement with this statement.

The next group of questions relates to the general view on the inclusion of gamification in learning and studies. First, the question of interest is whether students consider Kahoot! and tools similar to it should be included in other subjects in studies – most respondents said they agreed with this statement (62.7%), while a minority, but still a large percentage of students, said that such a tool should not be included in all subjects in studies (25.6%). The rest of the students did not have an opinion on this issue.

Asked if students felt that including gamification in learning facilitated their learning, the respondents answered, in the majority, that such tools did affect facilitated learning (41.6%), while a certain number of students (52.5%) said that gamification did not affect facilitated learning. The remaining number of students did not express their views on this question. Such difference in responses was expected, given that gamification-based tools should support learning and facilitate the repetition of teaching materials, and have no impact on student learning alone [8]. Also, when asked whether engaging with gamification in learning reduces the time they need to learn, students in the minority respond affirmatively (42.4%), while most students (57.6%) say that gamification does not affect the time they need to master some material.

Lastly, students respond positively to the most common question about their attitude regarding the use of gaming in learning. The majority of students report that the use of gamification in learning has a positive effect on their learning performance and contributes to the easier repetition of the course material (88.8%). In comparison, a significantly smaller number of students (10.8%) stated that the use of such tools does not affect their learning performance, and the rest of the students (0.4%) stated that using such tools had a negative effect on their learning. Graphically presented in Fig. 2.

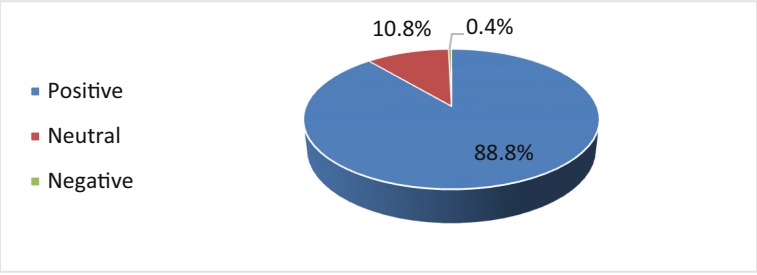

Fig. 2. Effect of using gamification on students learning performance (source: author's survey)

Table 1. Results from previous research [9]

RQ	Survey statement	Agreed	Disagreed
RQ1	Kahoot! encouraged students' active involvement in teaching	78%	22%
RQ1	Kahoot! encourages positive competition among students	83.3%	16.7%
RQ2	Kahoot! helped students' to repeat coursework	87.3%	12.7%
RQ2	Kahoot! facilitates student learning	27%	73%
RQ3	Gamification has a positive effect on students' learning performance	86%	14%

Compared to the results obtained in the previous research, presented in Table 1, it is found that students respond better to the use of Kahoot! in an online learning environment

(RQ4). Each of the survey statements has a higher percentage of agreement within the research conducted in the online learning environment (RQ4). The results of the research are presented in Table 2.

Table 2. Survey results

RQ	Survey statement	Agreed	Disagreed
RQ1	Kahoot! encouraged students' active involvement in teaching	91.9%	8.1%
RQ1	Kahoot! encourages positive competition among students	87%	12.6%
RQ2	Kahoot! helped students' to repeat coursework	92.2%	7.8%
RQ2	Kahoot! facilitates student learning	41.6%	58.4%
RQ3	Gamification has a positive effect on students' learning performance	88.8%	11.2%

5 Conclusion

The rapid development of technology has contributed to significant changes in education, which calls into question the effectiveness of the traditional approach to teaching and the repetition of materials in higher education.

Based on the research conducted, it became clear that students are ready to include a game-based software tool - Kahoot! (RQ3) in the teaching environment and that it positively influences their involvement in a unit that is in the process of repeating material or is currently being processed. Compared to previous research [9], we conclude that students use Kahoot! gives an even better result in terms of online learning (RQ4).

Kahoot!, as an example of a game-based software tool, students have widely recognized as a tool that positively influences their motivation in the process of acquiring new knowledge and repetition of material (RQ1). Also, the fact that such a tool should be used in teaching environments, as well as students' suitability for learning, can be confirmed by analyzing the respondents' answers regarding the inclusion of gamification and in other subjects in studies, where most have confirmed that they believe that game-based software tools should be introduced in most subjects in studies. When it comes to motivation, we must also analyze the competitive concept of such tools. Kahoot! was rated by the respondents as a tool that influences the creation of positive competition between students which also influences students' motivation during the course (RQ1).

On the other hand, when asked whether such a tool influences the facilitated repetition of the learned - the repetition of the material processed in the previous units, most students respond positively, which leads us to the conclusion that the use of such a tool in the repetition of the material, as one of the segments of learning, has a positive impact on students and their results (RQ2). Finally, based on this research, it is concluded that students respond positively to the introduction of Kahoot! tools and tools based on gamification and open access to new technology in teaching.

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Improving the Reliability of Pneumatic Control Systems by Using Remotely-Controlled One-Way Flow Control Valve

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Abstract. In order to achieve an adequate level of flexibility and reliability in the traditional industrial plants, in line with the Industry 4.0 approach, they need to be upgraded by integrating modern control procedures. This means developing new control algorithms, integrating new components into the system, etc. This paper presents a new phase in the development and implementation of a remotely-controlled one-way flow control valve, which is used for the remote control of actuator velocity in pneumatic control systems, during the working process. In this way, the optimum, not the maximum possible actuator velocity at all times is enabled. This directly effects the reliability of the system as it extends the working life of component.

Keywords: Remote flow control · Velocity control · Pneumatic control systems · Reliability

1 Introduction

In order to achieve an adequate level of flexibility and reliability in the traditional industrial plants, in line with the Industry 4.0 approach [1], they need to be upgraded by integrating modern control procedures. This means developing new control algorithms, integrating new components into the system, etc. Accordingly, the major global manufacturers are trying to improve their products by integrating modern electronic and computer technologies. These changes did not bypass pneumatic equipment. Right on their ability to adapt to new technologies, the pneumatic systems have remained a practically indispensable part of industrial processes for decades. They are present both inside (on the equipment that is used for the production or material handling) and outside factories (in the case of transporting and delivering products). Modern pneumatic systems require the use of advanced equipment, and today, the major worldwide manufacturers are making digital valve terminals. In this way, using single hardware element, with the appropriate control electronics and the appropriate software solutions, it is possible to replace a large number of traditional components. The main disadvantage of using such technologies is the high cost, because such solutions (for example, Festo Motion Terminal VTEM [2]) require the use of specific, piezo valves.

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 64–70, 2022.
http://doi.org/10.1007/978-3-030-97947-8_9

Depending on the needs and capabilities of the production system, sometimes, only one part of the production process needs to be raised to a higher level of automation. Accordingly, it is sometimes necessary to install only one additional component and implement the appropriate software solution to achieve the required results. Thus, pneumatic equipment manufacturers have developed electrically operated pressure regulators to allow the change of value of the operating pressure, during the operation process, without direct physical contact with the component, in order to reduce the compressed air consumption. This directly influences the improvement of the production process as it reduces energy consumption [3], which is in line with the basic Industry 4.0 approach.

Modern electrically controlled pressure regulators are designed so that the electromotor is connected to the head of the regulator adjusting screw via a suitable coupling, and the pressure value is adjusted by turning the shaft of the electromotor instead of manually turning the screw. In addition, a non-return valve in parallel with the pressure regulator as well as an outlet pressure sensor are installed. In this way, a new modular unit is obtained. Traditional pressure regulator becomes "smart" and can continuously communicate with the control system and other components. The development of new elements also requires the development of new symbols, so, for the previously mentioned pressure regulator, is proposed a new symbol [4].

Another important parameter (in addition to operating pressure) in pneumatic systems is compressed air flow. The compressed air flow refers to the amount of compressed air which are flowing through a corresponding cross-section in a time unit. One way for change the flow rate, which effects on the actuator velocity, is to use a one-way flow control valve. The amount of compressed air which is flowing can be controlled in one direction by turning the conical bolt. One-way flow control valves are components that are very commonly used because it is desirable that the actuator operates at optimum rather than maximum possible velocity. This also effects the extension of the working life of component and further improve the reliability of the system. In accordance with the need for the remote flow control, in order for the actuator to operate at the optimum velocity at all times, during the working process, at Faculty of Technical Sciences in Novi Sad is developed a remotely-controlled one-way flow control valve. In this paper, a new phase of its development is presented. The previous versions of this component are shown in the papers [5, 6]. Also, in paper [7] is proposed a new symbol for the newly developed component.

The paper is organized as follows: Sect. 2 shows the experimental setup for the component development, as well as the mechanical construction of the component. In Sect. 3 is presented a test application for remote control of a component as well as the obtained results. Finally, in Sect. 4, the most important conclusions are drawn and directions for further research are presented.

2 Remotely-Controlled One-Way Flow Control Valve

During the development of this component, one-way flow control valve, type GRA-1/4-B, from Festo, was used. It was integrated into the experimental setup shown in Fig. 1 (1V1). A stepper motor was connected to one-way flow control valve via a suitable coupling. The value of compressed air flow at the output of one-way flow control valve

was measured for different positions of the stepper motor, by using Air Box laboratory [8]. The percentage of openness of the valve was changed from fully closed to fully open, in precisely defined steps. It was determined experimentally that with the increasing of the percentage of openness of the one-way flow control valve, the compressed air flow rate increases and, at one point, enters in a saturation, thus reaching the upper and maximum value. This maximum value changes in accordance with the change of operating pressure. It was found that the maximum flow rate is, for example, 90 l/min for operating pressure of 2 bar, or 180 l/min for operating pressure of 5 bar and 6 bar.

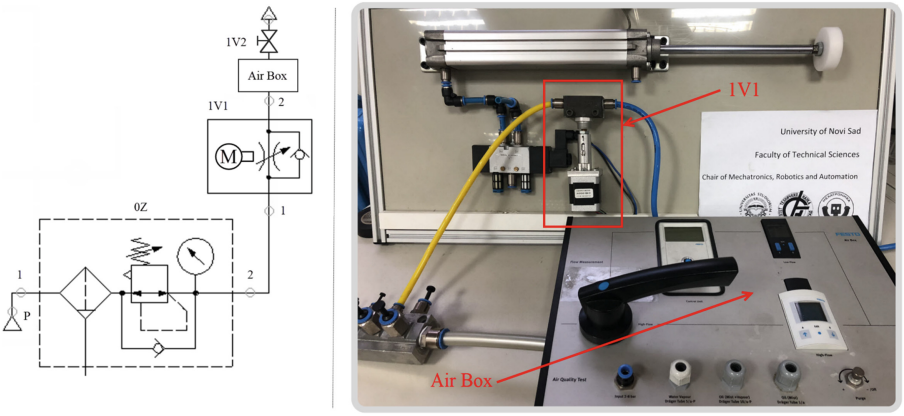

Fig. 1. Experimental determination of flow values: Pneumatic control scheme (left). Experimental setup (right).

In the next step, by using polyfit function in MATLAB, which returns the coefficients for a polynomial $p(x)$ of degree n, are defined the inverse polynomial functions that describe the dependence of the number of steps of a stepper motor and the compressed air flow rate (which is the value specified by the user). These functions are three-segmented ones, due to the optimal reduction of the function approximation error. It should be noted that for different values of operating pressure, the polynomial functions have the same degree but different coefficients. Thus, for example, for a value of operating pressure of 2 bar, the obtained functions are expressed by formulas 1–3:

- for flow values up to 16.21/min:

$$y = -0.9456x^5 + 53.1125x^4 - 1162.9x^3 + 12361x^2 - 63249x + 12431 \quad (1)$$

- for a flow values between 16.21/min and 53.441/min:

$$y = 0.0079x^3 - 2.0819x^2 + 181.7664x - 95.6121 \quad (2)$$

- for flow values which are exceeding 53.441/min:

$$y = -0.0029x^3 + 1.0739x^2 - 59.8008x + 5476.9 \quad (3)$$

wherein, in all three formulas, y is the number of steps of stepper motor, and x is the value of flow.

The physical realization of the prototype of the valve is shown in Fig. 2.

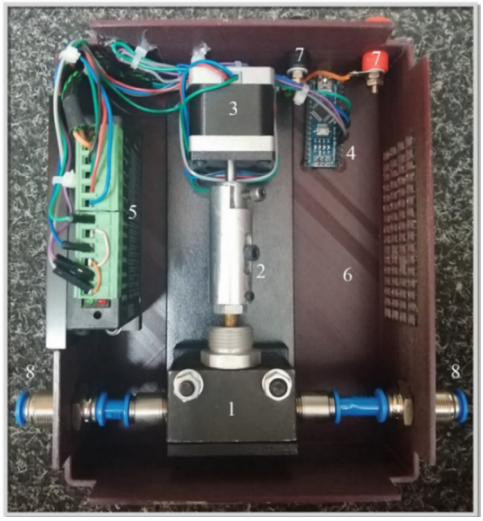

Fig. 2. The prototype of remotely-controlled one-way flow control valve, without cover.

As mentioned above, the remotely-controlled one-way flow control valve consists of a standard one-way flow control valve, in this case, type GRA-1/4 -B, from Festo (Fig. 2, position 1), appropriate coupling (Fig. 2, position 2) and stepper motor, NEMA 14 (Fig. 2, position 3). The Arduino NANO microcontroller development environment (Fig. 2, position 4) was used to control the operation of the stepper motor. The connection between the microcontroller and the stepper motor was made by using the appropriate driver (Fig. 2, position 5). The main housing (Fig. 2, position 6), as well as all the necessary mounts, was made on a 3D printer, by PLA. Several holes were made on the housing: for the power ports (Fig. 2, position 7), for the Arduino NANO USB port (below), and for the ports of one-way flow control valve (Fig. 2, position 8). The right side of the housing is partially provided in a grid, due to cooling.

3 The Software Solution

For the purpose of testing of a developed prototype of remotely -controlled one-way flow control valve, an application called "Remotely_controlled_one_way_flow_control_valve.exe" was developed, in the Java programming language (Fig. 3). A standard serial RS 232 communication protocol is used to establish a connection between the main control unit, the Arduino NANO microcontroller development environment, and the server computer, on which is installed the user application.

Therefore, at the beginning of the work, it is necessary to enter the name of the communication port, for example "COM 1", in the field "Select communication port" (Fig. 3, position 1). The baud rate is predefined. In the next step, by click on the button named "Connect" (Fig. 3, position 2), the connection is establishing. If the connection is established successfully, in the field named "STATUS" will be displayed a text: "The device is successfully connected". Otherwise, it will be displayed a text: "Connection failed. Please try again".

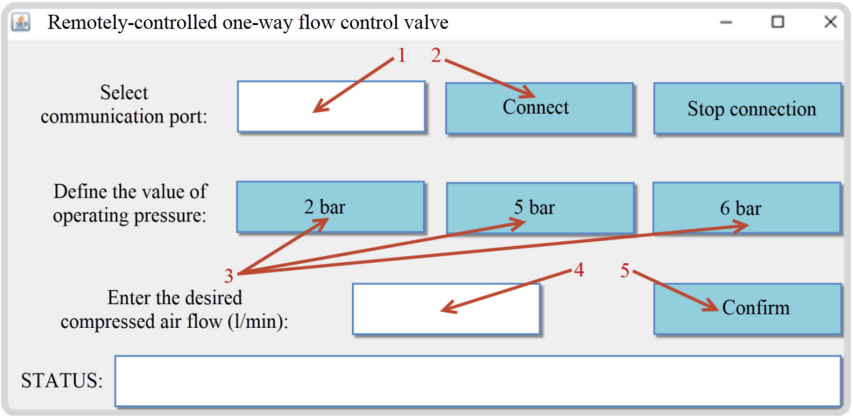

Fig. 3. User application

In the next step, the user defines the value of the operating pressure by clicking on the desired button (Fig. 3, position 3). In this application which is used for testing the functionality and accuracy of the developed prototype, there are three defined values of operating pressure: 2 bar, 5 bar and 6 bar. After that, the user enters the desired compressed air flow (Fig. 3, position 4), which must be in the predefined range, from zero to maximum value (90 l/min for operating pressure of 2 bar, or 180 l/min for operating pressure of 5 bar and 6 bar). By clicking on the button named "Confirm" (Fig. 3, position 5), the parameters are being sent to the microcontroller. According to a predetermined algorithm, the microcontroller adjusts the position of the stepper motor, and controls the operation of the one-way flow control valve. If the value of the desired compressed air flow is outside of the defined range, after clicking on the button named "Confirm", in the field named "STATUS" will be displayed a text: "The defined flow is not within the permitted limits. Please, enter the new flow value again". Otherwise, after calculating the rpm, the microcontroller will adjust the position of the stepper motor, and thus the remotely-controlled one-way flow control valve will give the desired compressed air flow.

3.1 Testing and Results

By using Air Box laboratory, from Festo, the achieved values for the compressed air flow, for the operating pressure of 6 bar, were measured. The obtained results, which

were used to test the accuracy and the repeatability of the developed remotely control one-way flow control valve, are shown in Table 1. The ordinal numbers of the tests are shown using Roman numerals from I to III. By analyzing the results is concluded that the maximum absolute error, which is calculated as the difference between the achieved and desired value, is −4.14 l/min, at a desired compressed air flow of 176 l/min. Considering that this is a non-feedback control system, the obtained results can be rated as very good.

Table 1. The results of measuring the achieved value of the compressed air flow on the newly developed remotely-controlled one-way flow control valve, for the operating pressure of 6 bar.

The desired value of compressed air flow (*l/min*)	The achieved value of compressed air flow (*l/min*)		
	I	II	III
48	48.42	47.9	48.15
80	80.02	79.56	80.01
128	126.58	127.45	126.23
156	154.22	152.84	154.64
176	172.23	171.86	172.87

4 Conclusion

In this paper is shown a new phase in the development and implementation of a remotely-controlled one-way flow control valve, which is used for the velocity control in the pneumatic control systems, during the working process. The application of this component in pneumatic control systems is in line with the Industry 4.0 approach. Namely, using of this valve has direct effect on the extending of the working life of component and, thus, directly effects the reliability of the system, because it allows the optimum actuator velocity at all times. By using this valve, the compressed air flow can be changed during the working process at any time, in accordance with the current requirement.

The future research will relate to further improvement of the developed component. Compared to existing software, a new way of accessing the main control device, the Arduino NANO microcontroller development environment, via Wi-Fi communication, will be implemented. Also, the transfer functions (that describe the dependence of the number of steps of a stepper motor and the compressed air flow rate), for the other values of operating pressure (for example, 3 bar and 4 bar), will be determined. On the other hand, compared to the existing hardware, it is possible to remove the server computer and to avoid the use of wire conductors, as well as to change the stepper motor driver, which would reduce the required space and thus the overall dimensions of the device, etc.

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Toward Real-Time Data Analytics Application for Industry 4.0

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Abstract. The Industry 4.0 is moving the production towards smart production systems, based on new technologies (i.e. Internet of Things, Cyber-Physical Systems, Cloud Computing, Big Data and Artificial Intelligence). Companies rightfully have high expectations of Industry 4.0. However, one of the major obstacles is how to transform reactive, via proactive, to predictive production systems. The predictive production systems are new type of intelligent production systems that enable the implementation of new technologies for discovering hidden information in the raw production data, this way enabling prediction and prevention of errors that could occur in production. The discovery of hidden information in the raw data is enabled by the real-time predictive data analytics on the basis of which the real-time decision making models are applied in the production system. The present study proposes a conceptual framework for real-time data analytics for Industry 4.0. The framework is developed based on the analysis of the available literature and informed with direct experience in implementing Industry 4.0 technologies in practice.

Keywords: Real-time data analytics · Industry 4.0 · Predictive production systems · Edge computing · Cloud computing

1 Introduction

The development of information and communication technologies offers opportunity to transform traditional production into a smart production. This digital transformation concept significantly impacts production processes and drives the fourth industrial revolution - Industry 4.0 [1].

Development of Industry 4.0 technologies (e.g. Internet of Things (IoT), Cyber-Physical Systems (CPS), Cloud Computing and Artificial Intelligence) results with the constant increment of amount of data obtained during production processes. Moreover, generation of large amount of raw data in production systems, called Big Data [2, 3], is becoming a key for optimizing production process and improving competitiveness [4, 5].

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 71–78, 2022.
http://doi.org/10.1007/978-3-030-97947-8_10

Thus, in this way, the data acquired across the product life-cycle can be converted into knowledge with positive impact on all aspects of production [6].

However, Big Data with all the positive expectations also brings challenges not encountered by production companies until now. Specifically, the biggest challenge today's production faces is the processing and analysis of Big Data. Consequently, the Big Data speeds up the development of data analytics technology for detecting hidden information among data collected by different machines and devices in the production processes using advanced analytical techniques (advanced statistical analysis, machine learning and expert systems). In this way, the emphasis is put on eliminating the issues that arise in production systems [7]. Another challenge of using Big Data is that very often it cannot be processed and analyzed using the existing software applications and personal computers due to insufficient processing power [4]. Therefore, new technologies, such as Cloud and Edge Computing, are using advanced data analytic techniques to detect hidden information to overcome the problems of processing and analyzing of the generated data.

The discovery of hidden information in the raw data is enabled by the real-time predictive data analytics. Based on real-time predictive data analytics, the real-time decision making models are applied in the production system [8] transforming a reactive production system into predictive. The predictive production systems enable proactive behavior permitting to anticipate the error before it occurs in the production process and to instantly take appropriate actions to avoid it [9]. Thus, we argue that in the near future of Industry 4.0 the real-time data analytics will play a mayor role in the development of the predictive production systems with ability of processing and analysing the data as it is generated in real-time [10].

The present research contributes to the body of real-time data analytics literature by proposing a conceptual framework for development of real-time predictive model for data analytics. Notably, the proposed framework represents the basis for development of real-time data predictive models based on datasets collected from production process.

The present paper is organized as follows. Section 2 provides a theoretical background of real-time data analytics for smart production systems and details on the research method. Section 3 proposes framework for real-time data analytics for Industry 4.0. Finally, Sect. 4 derives conclusions and provides information on the future research.

2 Theoretical Background and Research Method

This section summarizes the state of the art of the research in the subject fields, namely: Industry 4.0, Predictive production systems, IoT, and real-time data analytics for smart production. Further, the research method is provided.

2.1 Background: Real-Time Data Analytics for Smart Production

Industry 4.0 - Recently, Industry 4.0, has become one of the major research and development topics for industry and academia [7, 8]. The concept of Industry 4.0 can be defined in different ways, depending on the point of view and field of inquiry [1, 7]. In the present research, the used definition of Industry 4.0 observed through lens of production processes in industry and the application of data science based on data analytics,

reads: “Industry 4.0 is a concept that aims to increase production processes efficiency by collecting and interpreting data using data analytic techniques (e.g. data mining, statistical analysis etc.) and developing of predictive models based on which real-time decisions are made and executed” [11].

Predictive Production Systems - Intelligent production systems represent new generation of production systems that include hardware parts of equipment and machines, and software components [2, 6]. These production systems use techniques such as expert systems, fuzzy logic, statistics and machine learning [3] for production processes control [2]. One of the biggest challenges of production processes control is the transition from reactive to proactive production system. On the one hand, reactive production systems apply a posteriori inspections to detect defects (i.e. machine failures or defect products) at the end of the production process and reactively implement changes in the production system [2]. On the other hand, proactive production system use predictive (i.e. a priori) approach that aims to prevent machine failures or defect products from being manufactured in the first place [2]. Predictive production systems are a type of proactive Industry 4.0 intelligent production systems [4]. Thus, according to the previously said, predictive production systems predict an error occurrence inside the system and take adequate actions for avoiding the error to occur at all [4]. The real-time data analytics represents the future of the predictive production systems since it enables the data to be processed and analysed while it is generated in real-time [10].

Internet of Things (IoT) - The increasing availability of production data is changing the way decisions are taken in industry regarding predictive maintenance and quality improvement using data analytical methods [12]. The implementation of advanced Industry 4.0 technology, namely Internet of Things (IoT) allows the higher availability of production data due to it’s ability of connecting different devices, communication technologies, sensor networks, Internet protocols, tags for RFID devices and so on [13]. The IoT combined with data analytics, can enable predictive production and networked production environments [4] for real-time data analytics [10].

Real Time Data Analytics - Data analytics, as a part of data science field, represents a practice for revealing hidden information among data collected from various devices further enabling real-time decision making in production systems using real-time data analytics [7]. Real-time data analytics, as a part of data analytics, refers to analytical techniques where data is processed and analysed while it is generated, in real-time [10] or near to real-time [14]. Among the available real-time data analytics research [15, 16] the main focus is put on real-time monitoring and quality controling without predictive abilities. Moreover, the recent systematic literature review [11] showed that data analytics implementation challenges are the most frequently addressed in the Industry 4.0 literature. Specifically, *“the inability to achieve real-time maintenance”* is one of these challenges ([11] based on [17]). The present research adds to discussion present in this literature stream.

2.2 Research Method

According to Phaal et al. [18] the term "conceptual" implies "concerned with the abstraction or understanding of a situation", while "framework" implies "supports understanding and communication of structure and relationship within a system for a defined purpose" (Phaal et al. [18] based on Shehabuddeen et al. [19]). Thus, conceptual frameworks "support understanding of an issue or area of study, provide structure, and support decision making and action" [18]. Conceptual frameworks are "needed to guide thinking about technology management, based on well-founded theoretical principles" [20].

The present research proposes a conceptual framework [18, 20] for real-time data analytics application for Industry 4.0. It does so by reviewing the relevant literature and conceptualizing a framework based on the findings. The proposed framework for real time data analytics is composed of three parts, namely: system characteristics, dataset characteristics, and IoT network infrastructure. Notably, the research presented is supported and additionally informed by researchers' insights obtained during the implementation of Industry 4.0 in industrial practice [21].

3 Proposed Framework for Real-Time Data Analytics for Industry 4.0

In the present research, we propose a framework for application of real-time data analytics for Industry 4.0 in production system (Fig. 1). The proposed framework is composed of: production system characteristics, dataset characteristics, and IoT network infrastructure.

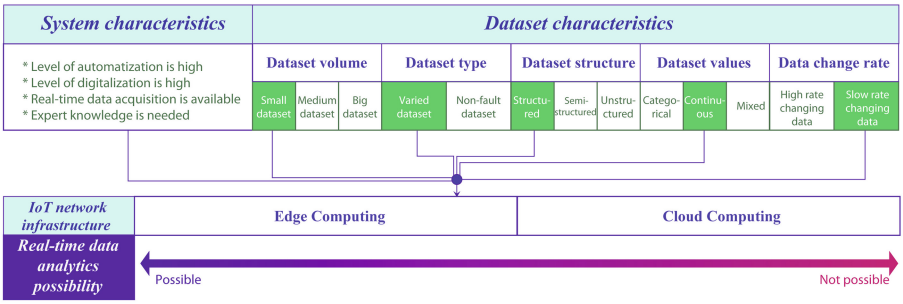

Fig. 1. Proposed framework for real-time data analytics

Production System Characteristics - Notably, we need to know and understand production system characteristics in order to determine if it is possible to develop a real-time data analytical predictive model for the observed production system [22]. Without production system characteristics it is very hard to imagine a real-time predictive model, because in general predictive model development is built on the characteristics of the production system it is meant to serve. Notably, production system that moves towards

implementation of real-time data analytics tends to have a high level of automatization and high level of digitalization which together enable real-time data acquisition [23] (Fig. 1). Also, expert knowledge must not be neglected, because there is a need for complete openness, sincerity, tight collaboration and constant communication between industry and researchers in order to obtain the synergy needed [24] for achieving real-time predictive production system. In this collaboration, industry practitioners provide the know-how on the observed production process, while researchers develop predictive models and test them in production systems [24] to improve the performances of the processes using real-time data analytics. Based on data acquired from production system, the dataset is formed.

Dataset Characteristics - Basic characteristics of acquired dataset are data volume, dataset type, dataset structure, dataset values and data change rate. In the following we elaborate on all five Data characteristics needed for implementation of real-time data analytics.

- Data volume - It is a generally accepted opinion that a large amount of data is necessary for the development of a predictive model for real-time data analytics [25]. However, recent research [26] points out the importance of small dataset in developing predictive models. Therefore, we argue that small carefully selected dataset based on experts' knowledge can provide an accurate prediction that is comparable with predictive models developed based on a medium or large dataset.
- Data type - The development of the predictive model with ability of real-time data analysis largely depends on the type of the data collected over a period of time in production systems [5]. Therefore, it is necessary to select a dataset without incomplete, homogeneous or noise data, which can disrupt the quality of a dataset [27, 28]. Thus, a high-quality dataset is crucial for developing an effective predictive model. A high-quality dataset is considered to consist of a certain number of samples from the periods when production system worked without problems, interruptions and difficulties, as well as a certain amount of data when certain problems occurred in the system [1]. Data samples from the periods when production system worked without any problems, interruptions and difficulties are defined as non-fault data samples, while data samples when certain problems occurred in the system are defined as fault data samples. Notably, the difficulty lies in finding of balance between the number of non-fault data samples and the number of fault data samples in order to obtain a varied dataset.
- Data structure - Production data is usually not in a format that can be used directly for data analysis [29]. Nevertheless, predictive models require a structured dataset. This means that dataset needs to be in the form of a matrix containing rows and columns, that is it is necessary for the dataset to be structured as a two-dimensional matrix [30]. The rows of the matrix represent all identified independent parameters, as well as one dependent parameter determined by the expert knowledge, while the columns correspond to each individual case (sample) recorded during the production process. Even though dataset needs to be in the structured form, in majority of cases the collected dataset is available in semi-structured and unstructured form. If the data is available in a semi-structured or unstructured form, the additional efforts are needed to convert the data into a usable structured form.

- Data values - Different values of dataset can be generated in production process, namely: categorical, continuous or combination of these two. On the one hand, for categorical variables, it is suggested that they are converted into binary value (e.g. value of variable can be either 0 or 1). If there are more than two levels in the categorical variable, a series of dummy variables should be used, where each defining the presence of a level [31]. On the other hand, continuous variables are numeric variables that have an infinite number of values between any two values. In other words, continuous values are numeric values [32]. Therefore, when collecting a dataset for development of a predictive model for real-time data analytics, the best choice is to use continuous value of a production parameter.
- Data change rate - Nowadays, large volumes of data are daily generated at high rate from heterogeneous sources during production process due to use of fast production equipment. This leads to fast change of data rate representing the frequency at which data is generated, captured, and shared [33]. Thus, the data arrives in stream and must be analyzed in real-time. That represents a difficulty for developing predictive model for real-time data analytics based on high-rate changing data. Therefore, in order to develop a reliable predictive model for real-time data analytics, the slow-rate changing data represents better option.

IoT Network Infrastructure - When considering the formed dataset, taking into account the characteristics of the production system, we need to choose IoT network infrastructure. The possibility of developing a predictive model for real-time data analytics depends on the right choice of IoT network infrastructure, i.e. Cloud Computing or Edge Computing. Bajic et al. [34] compare the Cloud and Edge Computing and stress out that these technologies do not rule out one another, but complement each other. However, on the one hand, the disadvantage of Cloud Computing is represented in the longer processing and computing times as well as a slower response time which prevents the implementation of real-time data analytics [34]. On the other hand, Edge Computing enables the data generation at the network edge reducing the distance that data must travel on the network enabling real-time data analytics implementation [34].

4 Conclusions and Future Work

The present research develops a framework for real-time data analytics (Fig. 1). It does so by analyzing the relevant literature and subsequently conceptualizing a corresponding framework. The framework is meant to serve as starting point for companies that would like to implement real-time data analytics as a part of transformation towards Industry 4.0. The proposed framework is composed of three parts, namely: system characteristics, dataset characteristics, and IoT network infrastructure. The research goes in detail with the dataset characteristics analysis.

In the future work, the developed conceptual framework for the real-time data analytics will be further refined and elaborated. Additionally, the research will move towards testing the proposed framework with the companies interested in implementing real-time data analytics.

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Software Tools to Support Visualising Systematic Literature Review

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Abstract. A systematic literature review is a *sine qua non* for performing significant research in the selected field. However, it is a complex, error-prone and time-consuming process. In order to reduce the probability of errors' occurrence during the literature review process, as well as to make it easier for researchers to perform this process, tools that support systematic literature review (SLR) are developed. Visualisation is essential for the conducting of SLR. There is a lack of researches about the software tools that could support SLR process by means of visualisation. This paper focuses on identifying visualisation tools that are currently used in practice to support SLR process. In the paper, we present and com- pare four tools in order to provide valuable information on current visualisation trends in the context of SLR, best practices, and preferable characteristics of visualisation tools for SLR.

1 Introduction

It is not possible to perform significant research without a deep understanding of the research area and mastering the literature that is fundamental in the area. However, if the review of the literature is not thorough, it usually has low scientific value. To make the literature review thorough and substantial, it takes to bring in specific rules, strategies and methods to the review. The literature review process that provides a predefined search strategy and is mostly used in scientific researches is a systematic literature review (SLR) [1].

The development of information technology results in an increased amount of data that is accessible to researchers. Since the number of data sources, which are available online, is growing every day, the usage of information technology with a research purposes means that the volume of conducted researches is increased and, consequently, literature growth over time is faster [2]. There are many kinds of research focused on developing and evaluating guidelines for conducting systematic literature reviews [3–8]. However, the support tools that could improve the quality or complexity of the systematic literature review process have not received the same level of attention.

Koch and Naotsugu claim [9] that among all the senses, vision is considered very dominant as it has a wide bit-rate of consumed information capacity for sensing.

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 79–86, 2022.
http://doi.org/10.1007/978-3-030-97947-8_11

Keeping that in mind, visualisation tools are very important in the context of SLR process support.

This paper focuses on an overview of the tools that use visualisation and can be employed for conducting a systematic literature review.

In order to give an overview of how systematic literature review could be supported by using different visualisation software solutions, systematic literature review activities are presented, and suitable tools with their features are proposed.

The remainder of the paper is organised as follows. The basic concepts of systematic literature review and related work are presented in Sect. 2. In Sect. 3, tools to support SLR through visualisation are described, and an overview of SLR activities that are supported within these tools is given. Conclusions and suggestions for future research are given in the Sect. 4.

2 Background

The methodology for performing systematic literature review used in this paper is the one developed by Kitchenham [3]. In this section is given an overview of the SLR process, as well as activities to conduct it.

Cochrane Collaboration defined systematic literature review as "an overview of a clearly formulated research question (or more research questions) that uses systematic and explicit methods to recognise, select and critically evaluate relevant researches, as well as collect and analyse data from papers included in the review" [10]. Statistical methods (meta-analysis) may, but do not have to be used for analysis and summarisation of the results that are included in the research [11].

A quality systematic literature review should fulfil all or at least most of the following requirements [7]:

- determine to which extent has previous research made progress towards clarifying a specific problem;
- identifying relationships, contradictions, gaps and inconsistency in literature and finding out the reasons (e.g. by recommending a new conceptualisation or a theory that explains the inconsistency);
- defining general statements and views or comprehensive conceptualisation (forming new ones, rather than summing up previously expressed views);
- commenting, evaluating, expanding or developing theory; and
- suggestion for guidance in future research.

Systematic reviews are characterised by being objective, systematic, transparent and repeatable, while Baumeister vividly recommends that when doing a systematic literature review, the researcher should be a judge and jury, not a lawyer [7, 12]. Judge and jury are sceptical when evaluating evidence in order to make a judgment as fair as possible, based on that evidence. In contrast, lawyers' approach includes trying the best case for one side of the argument.

Considering all of the above, we can conclude that this process reflects the current scientific knowledge about a certain topic [13].

The systematic literature review includes several different activities [3]:

- review planning,
- review execution, and
- documenting.

Stages of planning the review are as follows [14]: identification of the need for a review, commissioning a review, specifying the research question, developing a review protocol and evaluating the review protocol. The stages associated with the review execution are [14]: identification of research, selection of primary studies, study quality assessment, data extraction and monitoring and data synthesis. Documenting or reporting the review consists of stages such as [14]: specifying dissemination mechanisms, format- ting the main report and evaluating the report.

In a research conducted by Hernandez and Kraft in 2013, participants stated that the most difficult activities in the systematic literature review are a selection of papers, data extraction and quality estimation of the papers [15].

What is especially important is to identify which are the activities that take the most time, since a systematic literature review is a long process and that time needs to be optimised. The results [16] show that the most time demanding activities are data extraction, selection of papers, and quality estimation, respectively.

This means that all ways of simplifying these activities to researchers should be taken into consideration.

3 Tools to Support Visualising SLR

Information can be seen as knowledge obtained from investigation, study, or instruction [17]. Visualisation alludes to the making of two-dimensional or three dimensional portrayals of information that empower new revelations of both insights and knowledge [18]. Together, information and visualisation describe the new, upgraded meaning that has changed the way of perceiving and understanding information. This concept pro- vides the opportunity to better understand and memorise the new knowledge that information gave to the information user.

Nowadays, the SLR process is still dominantly executed manually, so it requires much time while, at the same time, can lead to mistakes. Taking this into account, as well as the fact that the amount of literature being produced and published is rapidly growing every day, we can conclude that traditional way of performing systematic literature review is unsustainable so it could significantly benefit from the usage of visualisation tools as a way to speed up the process of understanding data [13].

We searched the literature to perceive whether there are tools that could support SLR by visualising data and information generated in the process of SLR.

Our criteria were that these tools are free and open to use, and we have selected and tested four tools:

1. Revtools,
2. CitNetExplorer,
3. VOSviewer, and
4. NAILS.

In the text bellow, those four tools are described. At the end of the section, table with a comparison of the features these tools provide to support SLR according to Kitchenham guides [3] is presented.

Revtools is an R package developed to support evidence synthesis projects. It can be used to visualise patterns in bibliographic data, to interactively select or exclude individual articles or words and save the results for later analysis [19].

We downloaded a list of references from the Web of Knowledge to test this tool. Instead of sorting data manually, Revtools helped to locate and remove duplicated titles, and then, to some extent, helped us choose relevant entries by viewing titles and abstracts. Revtools reduced our usual time needed to conduct evidence-synthesis and helped us choose relevant papers.

However, there could be some obstacles for researchers that are using this tool. Basic programming skills and familiarity with R are needed in order to use Revtools.

In their paper, van Eck and Waltman [20] used CitNetExplorer and VOSviewer to demonstrate how these tools can be used to cluster publications and to analyse the resulting clustering solutions.

CitNetExplorer focuses on the analysis at the level of individual publications. This tool can be used to simplify systematic literature search in many ways, by making it possible to easily select all publications that cite or are cited by a given set of publications [21].

We used it to discover the publications that are the pillars in the field of e-learning in higher education. Using data extracted from the Web of Knowledge, we needed just a few minutes to get the results, since visualisation helped us to easily extract information. This process would take much longer if it was done manually. Our result is shown in Fig. 1. The vertical location of a publication is determined by its publication year, and the horizontal by its citation relations with other publications. In that way it was easy to determine four main publications on which further publications rely. It is possible to select one publication and to see publications that are predecessors and followers of that publication.

Unlike CitNetExplorer, VOSviewer is focusing on the analysis at an aggregate level. VOSviewer is a software tool for constructing and visualising bibliometric networks.

Authors [20] showed an example of using VOSViewer by making two visualisations. The first visualisation showed the clusters in a clustering solution and the citation relations between these clusters. The second visualisation was using a socalled term map to indicate the topics that are covered by a cluster.

We used VOSviewer to examine when e-learning was hot research topic in which country. VOSviewer saved us a lot of time by visually presenting and extracting the information in just a few seconds. From the graph shown in Fig. 2. we could easily determine information about countries and their research in the field of e-learning. Developed countries mostly researched in this field until 2014, while less developed countries mostly researched it from 2018.

NAILS is a tool which uses a series of custom statistical and network analysis functions to give the user an overview of literature datasets. The system then removes duplicate records and performs an exploratory data analysis on provided literature data. The analysis identifies, for instance, the most cited articles and authors, most common

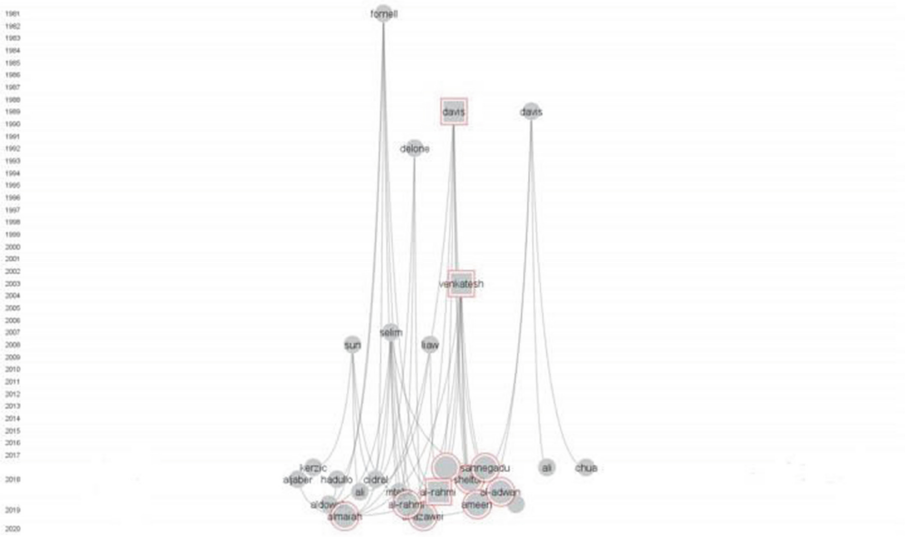

Fig. 1. An example of CitNetExplorer usage

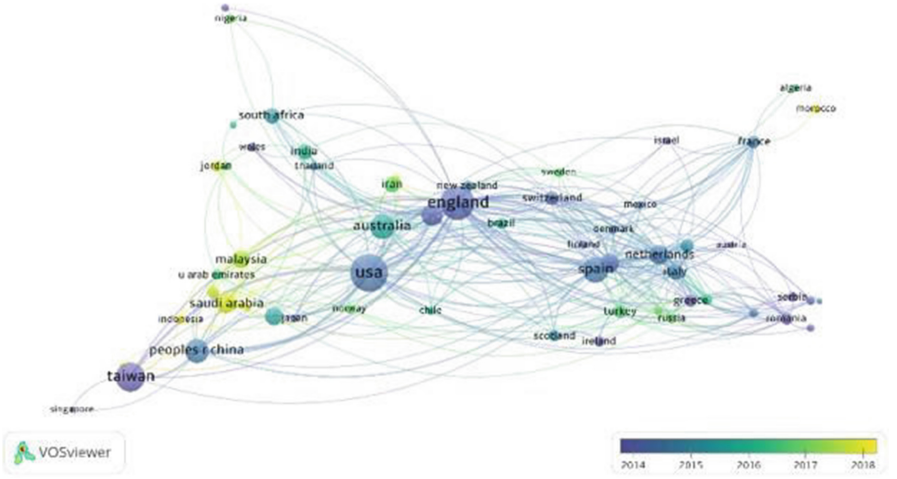

Fig. 2. An example of VOSviewer usage

keywords, and journals with most publications. These statistics are accompanied by visualisations for a quick data overview [22]. Unlike tools described above, NAILS does not support adjusting parameters, so it visually generates information of the entries exported from databases such as Web of Knowledge. NAILS supported our SLR process by helping us to review searches on Web of Knowledge.

While using these tools, we concluded that they could help researchers in planning the review by visually showing summary results from different queries in Web of Knowledge

or Scopus and help them to define a query and examine some stages of planning the review. These tools could significantly improve the review process protocol evaluation. In Table 1 are summarized the main features of reviewed visualization tools.

Table 1. Features enabled by the tool.

Feature	CitNetExplorer	RevTools	VOSviewer	NAILS
NAILS Identification of research	X	X		X
x Selection of primary studies	X	X	X	X
Study quality assessment		X		
Data Extraction and monitoring	X		X	X
Data synthesis	X	X	X	X

All of these activities are supported only if data is extracted from the Web of Knowledge, Scopus or similar bibliographic source, one at a time. This is the biggest limit of these tools. Since their purpose is to reduce the time needed to extract the in- formation, pre-processing the data manually for these tools would take much time for the researcher. They are useful to some extent and need to be upgraded for full support of the SLR process.

4 Conclusion

Information visualisation is a cognitive process that is used for analysis and presentation, allowing us to better understand data and offering the opportunity to act upon the understanding it offers. It also enables effective communications and presen-tations, further solidifying the fact that the purpose of visualisation is to gain insights, rather than merely viewing pictures. In the paper we discussed the appliance of four tools aimed at information visualisation in order to support SLR process.

While tools for visualising text data are not yet common in systematic literature reviews, expanding their use will be critical if systematic reviews are to remain viable, given projected increases in the size of the academic literature.

There are tools that could, to some extent, support systematic literature review and those tools can be used to carry out different steps in this process. However, none of the currently existing tools can be used to support the SLR process from the first to the last step. One of the biggest problems is that there are not enough researches that are evaluating those tools.

The researchers need adequate tools to support SLR process. Presented study is just the first step in a broader study of SLR tools, aimed at identifying best practices, and preferable characteristics of SLR support tools. Such a comprehensive study will enable the definition of guidelines for design and development of unified tool that will be able to fully support in time and quality all the activities of the SLR.

Acknowledgements. This research (paper) has been supported by the Ministry of Education, Science and Technological Development through the project no. 451-03-68/2020-14/200156: "Innovative scientific and artistic research from the FTS (activity) domain".

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Learning Environment Digital Transformation: Systematic Literature Review

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Abstract. We are witnessing how digital technologies can be used to transform everyday life – launch new or grow incumbent companies, change teaching and learning environment, and research. The latest literature research has overwhelmingly positively assessed the use of digital technologies in higher education, indicating certain challenges in this regard. In the modern era, higher education institutions need to evolve steadily, following the digital transformation. Overall, the emphasis is on the encouragement and promotion of digital technology in the learning process. However, a small number of research papers addressed the learning environment's digital transformation in the past decade. With the aim of contributing to a relevant topic, this paper presents a systematic literature review of related articles published on learning environment digital transformation in ten years. Accordingly, significant and eminent results are discussed, together with guidelines for future research.

Keywords: Digital transformation · Learning environment · Literature review

1 Introduction

Digital tools' capacity to enhance peoples' lives has led the internet to become the primary medium through which many people communicate. The internet, side by all digital tools, becomes one of the essential media of digital transformation.

According to one of the biggest worlds' digital transformation company, Salesforce[1], digital transformation is defined as "The process of using digital technologies to create new, or modify existing, business processes, culture, and customer experiences to meet changing business and market requirements". This everyday business reimaging in the digital age is called digital transformation.

Despite earlier claims that new generations carry information and communication skills within [1], empirical researches show this is not the case [2–5]. Such results are the starting point for additional research on how teaching staff and students use digital, educational technologies in higher education [4, 6–9] before institutional policies towards the digital transformation of universities are successfully implemented.

[1] https://www.salesforce.com/eu/.

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 87–94, 2022.
http://doi.org/10.1007/978-3-030-97947-8_12

Following the above, the basic need for research is identified as follows. Since digitalization affects all segments of society, it is inevitable to deal with it primarily in higher education institutions. In addition, to meet the expectations of students and teaching staff, leaders toward digital transformation in education must be confident that their digital environment can adapt to this technological advancement.

This paper, through the presentation of the systematic literature (SLR) results, aims to establish to what extent existing research has progressed towards learning environment digital transformation. Furthermore, the goal of the paper is to formulate general statements, and eventually to identify gaps in research in the last ten years to suggest areas for further investigation. The literature review on the digital learning environment is based on the guidelines for performing SLR by Kitchenham, B. [10].

The rest of the paper is organized as follows. Section 2 provides an overview of the learning process evolution towards digital transformation. Section 3 presents the SLR research method. Section 4 and 5 present two main phases of the SLR – planning and conducting the review with all belonging steps explained. Section 6 discusses the review results and highlights the findings. Finally, Sect. 7 presents paper conclusions together with future work proposals.

2 Learning Environment Digital Transformation

The digital revolution within Industry 4.0 influences emerging changes in the modern era. New technologies have been accompanied by changes in the teaching and learning patterns, research habits, redesigning of existing study programs to meet and follow industry expectations [11].

For the initiation of the digital transformation in the processes of teaching and learning within higher education institutions, it is vital to understand the technical skills and knowledge of two perspectives – teaching staff and students. Some researches [12–15] provide insight into how teachers and students use digital tools in the learning environment. These results indicate the need for better professional development of teachers to deal with digital literacy at the academic level.

Recent studies have been increasingly mentioning and studying the usage of digital technology in higher education [16]. While some point out the challenges in this area, generally, the emphasis is on the encouragement and promotion of digital technologies and tools in higher education [17]. Other authors also showed the strong effect of using digital media tools such as Facebook, Instagram, Twitter for attracting new students [18]. It is necessary to reconstruct attitudes towards the use of technology in the teaching process, which would ultimately have a positive impact on the digital transformation in higher education [17].

3 Research Methodology

The main focus of the systematic literature review is to address problems related to a specific research question, or topic area, or phenomenon of interest, by identifying, evaluating, and interpreting the findings of all relevant individual studies.

3.1 Systematic Literature Review Procedure

The procedure includes three main phases of the systematic literature review: Planning the Review, Conducting the Review, and Reporting the Review [10].

During the planning phase, the first thing to identify is the overall need for the review. Second, the Review protocol that guides and specifies the SLR execution should be developed including the following information: motivation for conducting the SLR, formulated research question(s) which will result in the definition of the search strategy for initial scoping of primary studies, inclusion and exclusion criteria, and data extraction formulation [19].

A pre-defined protocol is essential to reduce the possibility of researcher bias and to avoid the selection or the analysis of the individual studies driven by researcher expectations. When the protocol has been created, the review can begin.

The second phase (Conducting the Review) of the SLR should be conducted in five steps [19]. The first step is to identify relevant research using the search string to query multiple databases and to identify a set of candidate studies. Second, researchers use the inclusion and exclusion criteria to eliminate irrelevant candidate studies, using titles first, abstracts second, and the full-text third. The third step is to perform a quality assessment of each study chosen to evaluate the reliability and importance of its results. Finally, the researchers extract essential data from all remaining studies using the data extraction forms. The extracted data is analyzed, and the resulting information is synthesized to draw conclusions.

Reporting the review is a single-stage phase that usually presents results in at least two formats, in a technical report or a section of a Ph.D. thesis, and a journal or conference paper [10].

4 Planning the Review

According to Kitchenham, B. [10], the initial step of the review planning phase should be the elaboration of the systematic literature review necessity in a particular subject. To present the need and the motivation for conducting the SLR, authors should review the existing literature on the relevant topic. Accordingly, no explicit, systematic literature reviews are presenting the digital learning environment transformation.

Intending to investigate the related background of the subject of interest, the authors of this paper stated the overall research question as follows:

How has the learning environment been digitally transformed over the years?

For the scoping of the primary studies, the search strategy is defined. Prior to creating the search strings, the research question was broken down into individual concepts as follows, learning process evolution, learning environment key concepts, learning environment participants, digital learning environment. This literature review consists of the search of relevant papers in the following databases: SCOPUS, Web of Science, and Google Scholar, using the search string presented below:

"Digital Transformation" OR *Digitization* OR *Digitalization*

AND

"Learning environment"

AND

university OR *college* OR "*higher education institution"*

Identification of primary studies strategy for this literature review was defined through 6 inclusion and exclusion criteria presented below.

1. The paper must address the process of digitalization in the learning environment.
2. The paper should observe the usage of digital services in the learning process from the end-user perspective.
3. Participants in the learning environment: students, teachers.
4. Published year – past decade: 2009–2019.
5. The papers presenting digital transformation in a non-learning environment should be excluded.
6. Duplicate papers collected from different databases should be removed.

After adopting the selection criteria, the researchers perform a quality assessment of each selected study to evaluate the reliability and importance of its results. Finally, the data extraction strategy applied to all relevant papers will extract publication year and source type of the papers, theoretical articles related to digitalization of the learning environment, in general, literature review papers, student and teacher perspective of the learning environment digital transformation.

5 Conducting the Review

The first step of conducting the review phase is the identification and selection of the primary studies to be included in the SLR based on the search string and inclusion/exclusion criteria.

5.1 Primary Studies Identification and Selection

Criteria followed for inclusion and exclusion are defined in the previous section of this paper. The systematic literature review process was conducted following the PRISMA statement [20]. After applying the previously defined search string to seek through databases, identification resulted in 1437 primary studies. At the screening stage, the first step was removing the duplicate records from different databases, where 181 have found as duplicate, and they were excluded from further research. Based on criteria 1 and 2, 1256 records were screened, and 881 primary studies have been excluded by title, and 180 by abstract. Eligibility phase assessed 195 full-text articles, whereas 85 were excluded following the exclusion criteria 6 – the papers presenting digital transformation in a non-learning environment should be excluded. Review based on criteria 3 and 4 included 111 primary studies in qualitative synthesis, as the papers addressing the

learning environment digital transformation. Further investigation on full-text papers has grouped the articles in the following concepts: blended learning and e-learning – 27 papers, m-learning – 13 papers, PLE – 3 papers, MOOC – 28 papers, Flipped classroom – 8 papers, primarily focused on the investigation of the process of learning environment digital transformation – **32 papers**.

Since the main goal of this paper is to present a systematic literature review on a specified topic, 32 primary studies are included for the final analysis in the review.

5.2 Data Extraction and Presentation

The final stage of conducting the review is the extraction of the essential data from all remaining studies using the data extraction strategy. The first presentation of the results differentiates the primary studies by years published. The results show one highest peak in the research regarding the learning environment digital transformation in 2018. The overall impression is there is a lack of studies that have been investigating the learning environment digital transformation. As far as the type of the paper is concerned, the majority of the papers were published as journal articles – 84%, while remaining are reports – 10%, books – 3%, and guides – 3%.

The articles observed in the past decade have been grouped in the five research segments, addressing the defined extraction strategy. Table 1 presents the main focuses of the previous research, as well as identified research gaps.

Table 1. Primary studies research focus

Research focus	Primary study	%
Digital transformation in HE	[2, 8, 9, 12, 13, 17, 21, 22, 24, 27, 29–31, 38, 40]	44
Digitalization strategy – experience	[32–34, 37]	12
Literature review	–	0
Teacher perspective	[6, 25, 28, 39, 41]	15
Student perspective	[3–5, 7, 26, 28, 35, 36, 41, 42]	29

Primary studies are focused on the general explanation of the digital transformation in higher education (HE), as well as on the digitalization strategy itself. Furthermore, extracted papers observed two main perspectives in the digitalization process, i.e., teachers' and students' perspectives of the transformation.

6 Findings and Discussion

Analysis in the past decade regarding the learning environment digital transformation presented in Sect. 5 has shown the overall deficiency in the previous research. Nevertheless, the learning process digital transformation has been presented through concepts which have changed the traditional learning to the digital extent.

As far as the literature review is concerned, the highest number of research papers regarding the selected topic was published in 2018. Selected primary studies, according to the data extraction criteria, have been grouped into five segments. The general theoretical articles addressing the digital transformation in higher education resulted in the most significant number of researchers – 44% in the past decade. Students' perception of the digitalization process in higher education institutions showed up as second due to the number of publications in the last ten years, with 29% of all research. Articles explaining the importance of the teacher perspective in the digital transformation of the learning environment are present with 15%.

Additionally, the digitalization strategy through experienced witness counted four elected papers in the SLR, which is 12% of all selected results. Finally, the papers which have been presenting the systematic literature review on the relevant topic resulted in zero articles, and thus identifies the gap in the literature. Consequently, this paper contributes to the research with the systematic presentation of the results focusing on learning environment digital transformation.

7 Conclusion and Future Work

Presented research has overwhelmingly accessed the digital transformation of the learning environment. Throughout the SLR, results showed how has the educational process changed affected by increased usage of digital technologies and digital tools. Likewise, this paper contributes to the relevant literature since there are no articles that have been presenting a literature review in this particular area.

Research has shown that being surrounded by technology in everyday life, even from an early age, does not automatically imply that one knows how to use digital tools effectively. Hence, besides all the significant advantages of digitalization, it is crucial to still educate students on how to use computer-supported learning environments for their benefit in learning. At that point, the question arises of how teaching staff uses digital technologies and do they have the relevant knowledge to transfer to students. Future research should provide more investigation on how teachers and students use digital tools and do they find them as improving the learning process towards the digital transformation.

Acknowledgement. This research (paper) has been supported by the Ministry of Education, Science and Technological Development through the project no. 451-03-68/2020-14/200156: "Innovative scientific and artistic research from the FTS (activity) domain".

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Overview of Application of Blockchain Technology in e-Government

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Abstract. Initially created as a technology to support peer-to-peer electronic cash systems, in recent years blockchain technology has been moving away from finance technology into other areas of application that could benefit from characteristics such as decentralization, transparency, and immutability. Significant researches are being done in fields of public services. In this paper, some of the prominent real-life applications of blockchain technology in e-government systems are presented. General benefits that could come to e-government systems from using this technology are also presented. Some open questions that exist in compatibility between e-government and blockchain technology are also being discussed, together with obstacles in the process of full integration of e-government and blockchain technology.

Keywords: Blockchain · e-government · Digital government · Smart contracts · Distributed ledger technology

1 Introduction

At the beginning of XXI century, the number of households in USA that owned a computer crossed 50% and more than 40% were connected to Internet [1]. By that time governments of developed and developing countries were using information and communication technologies (ICT) for running their day to day operations. With this infrastructure laid out and with success of different e-businesses, a spread of e-government (electronic government) was inevitable. E-government, or so-called government 2.0, represents a system founded on ICT that is intended to provide more efficient and more effective service to all stakeholders. E-government not only supports services that are provided by government, but also to provide ICT support for person to person (P2P), person to business (P2B) and business to business (B2B) services in secure, trusted, transparent, and reliable way.

According to 2020 UN E-Government Survey, all countries of the world are putting significant effort in improving their e-government services to interested parties with 126 of 193 UN member states being rated as countries with high level of e-government development [2]. By changing the way governments provide their services to stakeholders from traditional "paper based" to modern electronic services; at the same time,

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 95–102, 2022.
http://doi.org/10.1007/978-3-030-97947-8_13

during last couple of decades, a new set of problems were introduced, mainly related to information system security. According to [3] in case of 244 e-government sites from 212 countries, 173 of them were vulnerable to Cross Site Scripting (XSS) or Structured Query Language (SQL) injection attacks. Attack on government services are usually wildly publicized and result in lack of trust and confidence of people using those services or being aware of their personal data being stored in those systems. Only during 2019 several e-government services came under attack with very severe consequences like: declaration of state of emergency in US state of Louisiana and in city of New Orleans; $2.5m ransom demand in case of Texas; delaying sales of 1500 homes in Baltimore; and the case of Lake City, Florida, where local government agreed to pay $500.000 ransom for recovering data. Main reasons for these problems are in the fact that most e-government systems are centralized and as such are prone to any kind of single point of failure attacks.

To fulfill the requirements put in front of the contemporary government and to create government 3.0, expansion of "traditional" ICTs with, so called, "disruptive" ICTs is proposed in [4]. Those "disruptive" ICTs are identified as big data, artificial intelligence, and blockchain. Provision of user-centric, agile, and innovative public services should also lead to establishing of digital government that represents a broader term then e-government [5].

Blockchain is one of the disruptive ITC technologies that could provide good solution for secure, decentralized, transparent and immutable information sharing. According to UN 2020 E-Government Survey, 10 out of 12 leading countries in e-government services are specifically referencing using blockchain technology in this area of application [2].

For the first time blockchain technology is mentioned in [6]. Main characteristics of blockchain technology are decentralization, immutability and transparency. Decentralization is described as elimination of trusted third party in process of verification of transactions. In blockchain, verification of transaction is "outsourced" to peer-to-peer network and is based on consensus mechanism. Immutability represents limitation on reversal of transactions. The fact that everything that happens on blockchain is public represents transparency [6].

So called blockchain 2.0 was introduces in 2014 by Vitalik Buterin [7]. The Most significant change over previous generation of blockchain was introduction of smart contracts. Smart contracts are defined as software system that automates the execution of contract terms [7]. They represent computer code that will be automatically executed by peer-to-peer network that can reduce administration, save cost, and improve efficiency [8].

This paper is intended to serve as starting point for measuring how much integration of blockchain technology and e-government has been successful in recent years and to identified questions that need to be addressed to make this integration even more fruitful.

Paper is organized as follows: after introduction in Sect. 1, related work is presented in Sect. 2. In Sect. 3 technology used for implementation of blockchain is presented. An overview of some real-life applications of blockchain technology in e-government is given in Sect. 4. In Sect. 5 possibilities for application of blockchain in e-government will be discussed. Paper ends will final thoughts and recommendations for future research in Sect. 6.

2 Related Work

Bitcoin, as first implementation of blockchain technology, exists since the beginning of 2009 and in early years most of the peer-review papers focused on the economic issue and influence Bitcoin had on the real world. This is in accordance with fact that even after Bitcoin, other applications of blockchain technology stayed in the realm of cryptocurrency and financial technology (fintech). According to [9] by 2017 only 67 peer-reviewed papers were published about application of blockchain technology in fields other than cryptocurrency. Out of those 67 papers, 28 were in discipline of computer science, 18 in information systems, 9 in law, 6 in finances, 5 in political sciences and 3 were not categorized. According to [9], literature review conducted in 2019 shows a change in trend. In the period 2014–2019 a total of 260 peer-review papers on blockchain technology were published and out of those 260, 58 were on subject of application of blockchain technology, followed by 26 on subject of IoT and blockchain and 22 on application of blockchain technology in government [10]. According to literature review of adoption of blockchain specifically in e-government 21 articles were identified by the end of 2017 [11].

In [12] framework of decentralized e-government peer-to-peer system that could be used to secure information stored in system and therefor increase the trust in public sector is proposed. Using blockchain technology as information infrastructure for public services is proposed in [13] where this technology is recognized for its great potential in both reforming and transforming public service. Process simplification, transparency, openness, information sharing, data safety, privacy, and reduce cost are some of the main advantages of application of blockchain technology in e-government, while scalability and trust of the technology represent the main challenges according to [14], while in [15] blockchain technology is recognized as an effective way that could lead to having more efficient government. In [16] data integrity and irrefutability of transactions are presented as main benefits of application of blockchain technology in e-government. Application of blockchain technology as a way to improve trust in public records and elimination of need for a government to act in a role of trusted third party is proposed in [17]. According to [18], blockchain technology could be used in e-government to solve the problem of highly centralized systems and the fact that those systems heavily rely on direct human interaction for control. Switching to blockchain technology over Client Server Trusted Third Party intermediary system in both developed and developing countries is proposed in [19].

Some of possible specific applications of blockchain in e-government are land registry, e-residency, and e-health as stated in [12] and [14], but also in taxation, industrial policy, education, and social policy [5]. Possible solution to some of problems that exist in land administration through application of blockchain technology is presented in [20]. Some countries and government have special interest in products with protected designation of origin and large number of those countries are experimenting with use of blockchain technologies [21]. Some further possibilities are stated in [16] where voting, vehicle registration, birth and marriage certificates are mentioned.

3 Overview of Blockchain Technology

In the first implementation of blockchain technology, Bitcoin cryptocurrency, intention of creator(s) was to eliminate the need of trusted third party in financial transactions. This was achieved by using asymmetric cryptography, cryptographic hash functions, and proof-of-work consensus mechanism. Asymmetric cryptography is a cryptographic system that uses a pair of public and private keys to authenticate and encrypt a message. Cryptographic hash functions are used to create a digest of any digital document. This digest represents a digital fingerprint of original document. In case of Bitcoin, SHA256 hash function is used.

According to [6], in case of Bitcoin, transaction are represented as a chain of digital signature where current owner uses his private key to sign a hash of previous transaction together with public key of new owner and adds that information to the coin. Proof-of-work represents one of existing consensus mechanism that can be used to verify the transactions in peer-to-peer network. Without consensus mechanism, it would be impossible to solve double spending problem without trusted third party [6]. Consensus mechanism acts as timestamp server creating an ordered list of transactions. In case of Bitcoin process is as follow, all transactions are being added to transaction pool. From that pool transactions are selected and added to a block. Apart from set of transactions, block consists of two more parts. First one is hash of previous block and the second one is nonce. Hash of previous block is used so every newly created block would get "connected" to previous block(s), that way a chain of blocks of transactions is created, ergo, blockchain. As a result, change in any previous block would require a change in all subsequent blocks that were created.

By requirement, cryptographic hash functions shouldn't be hard to calculate, therefor it would be possible to recreate an entire blockchain rather quickly and that could lead to split in blockchain and make it impossible to determine which chain holds the correct data. That is where proof-of-work and nonce are used to solve this problem. In case of Blockchain, nonce is 32bit long block that is used to make it possible to set certain requirements that block hash should meet. That requirement is that hash must have a value that is lower or equal to current blockchain's target hash. This, so called difficulty level, is calculated based on total computer power involved in peer-to-peer network.

Apart of mentioned proof-or-work consensus algorithms other algorithms are being used in different blockchains such as proof-of-stake, delegated proof-of-stake, ripple, byzantine fault tolerance or thundering [22].

Since Bitcoin biggest change in blockchain technology was appearance of Ethereum blockchain, blockchain 2.0, which introduced the first Turing complete language for writing smart contracts. Smart contracts were firstly proposed by Nick Szabo in [23] where he defined them as digital set of promises that will allow for different parties to perform actions on those promises. Smart contracts enable creation of distributed application organization that would run on blockchain and that can benefit from everything that blockchain technology can offer.

4 Examples of Application or Blockchain Technology in e-Government

In this Section some representative real-life cases of application of blockchain technology in fields that are commonly related to e-government such as e-residency, e-health and land administrations are presented.

One of most prominent projects regarding e-Residency is one provided by Estonia. Estonia is in general one of the leading world countries in e-government and in application of blockchain technology in e-government. Estonian e-Residency is special offer for entrepreneurs that want to start their business in European Union country. E-residency holders can establish and run online companies, use electronic banking services, have access to international payment providers, digitally sign documents, verify the authenticity of signed documents and declared taxes online. Basically, it offers holders a possibility to use services of Estonian e-government and to start an online company from anywhere in the world [24].

System phrOS is another example of application of blockchain technology in e-health with focus on sharing health data while preserving data privacy. It provides services for patient identities (IDs) that enables patient identification and identity management, medication management, and social care records. Smart medical chain is another feature of this application that represents electronic health record based on blockchain and promotes sharing those records between healthcare providers thus improving the efficiency of healthcare information exchange. Application uses smart contracts as a form of e-consent form that should be signed by patients and it also provides automated insurance due to healthcare data authorization between patient, hospitals, and insurances [25].

Most prominent example of application of blockchain technology in land administration system is from Sweden. In collaboration of The Swedish Mapping, cadaster and land registration authority (Lantmateriet), Telia Company, ChromaWay and Kairos Future, a reform of transfer of real estate in Sweden has been made. In traditional process of buying a real estate involving mortgage had 34 steps and with application of blockchain technologies, new process has only 6 steps and time needed to registered a transaction in land administration that was up to 6 months, was significantly reduced. In case of this solution, basic information about transaction, such as content of contract, price and date of transfer, are stored on blockchain [26].

5 Discussion

Implementation of blockchain technology in e-government poses several questions that need to be addressed first. Those are related to how justifiable is application of blockchain technology in specific case, what direct benefits blockchain technology bring to specific application, should some existing implementation of blockchain technology be used as well as between public or private blockchain.

In [27] ten questions decision path is proposed for determining if blockchain technology is in fact a good choice for certain application. In general, if answer to any of the first seven questions is no, then blockchain technology is probably not the best solution.

On more lenient approach, five yes answers to first seven questions usually means that application of blockchain technology on selected problem is feasible.

Regarding direct benefits of application of blockchain technology, in general, greatest possibilities are in fields where having some of core blockchain characteristics is of advantage. For example, in developing and less developed countries decentralization is probably the most widely needed feature. Corruption in government institutions lead to lack of trust in government. "Replacing" government appointment officers with mathematically based consensus mechanism is a great advantage. Also, making transactions public and immutable prevents later "intervention" in data that could happen for some reason. Even in developed countries, trust in government is not granted and unquestionable by all citizens.

Question of selecting between existing blockchain infrastructure or creating a separate blockchain base on the same technology also needs to be addressed. How willing a state would be to "outsource" some task to a platform that is not under government control by choosing existing implementation?

Another question is whether public (permissionless) or private (permissioned) blockchain should be used? Public blockchains are those where anybody can join, become a node and verify transactions, while private blockchains have limited number of predetermined nodes. Should everybody be allowed to verify transaction or only those that are recognized as stakeholders can join the network?

Selecting a specific implementation of blockchain also means selecting a specific consensus mechanism. Proof-of-work is a consensus mechanism that requires a significant amount of computer power and energy (in case of public blockchains) to verify a transaction. Proof-of-stake tries to solve this problem by replacing computer power with stake a node has in network.

Question of privacy is another issue worth mentioning. Transparency, as one of main characteristics of blockchain now must be in concordance with General Data Protection Regulation (GDPR).

Even with all these questions answered there are still some limitations "built-in" blockchain technology, most notably the question of scalability. For example, Bitcoin network can manage less than five transactions per second at its peak time, while Ethereum may handle up to fifteen transactions. Most commonly used comparison is that Visa payment system handles an average of 1700 transactions per second. There are large number of public blockchains that attempt to solve this problem, but at this point in time none of them manage to get the number much higher than already mentioned Ethereum expect in test conditions. Work is being done in Hyperledger that could support up 50.000 transactions per second while Microsoft Azure Blockchain is reportedly aiming to support 100.000 transactions per second.

It is important to mention that blockchain technology is not 100% secure, there are security issues that should also be kept in mind when applying this technology and most notable ones are selfish mining attack, Border Gateway Protocol attack, Eclipse attack and 51% vulnerability.

6 Conclusion

While number of blockchain applications grows, large number of biggest IT companies are investing resources in further development, and governments of majority of countries have some blockchain project in development, there are still some issues that need to be resolved. Blockchain is surely not a solution for every e-government application, but as shown with several real-life examples, it can be used for specific cases. Also, it offered a new view on how certain services of e-government could be implemented in future.

Based on discussions from this paper, further research is aimed into creating a tool that would help answering some of those questions. That tool could be used measure how justifiable application of blockchain technology is in a specific e-government application and, at the same time, if application is justifiable, how to select proper implementation of blockchain technology that would serve specific purpose.

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Technical Debt Payment Practices and Rationales Behind Payment Avoidance in the Serbian IT Industry

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Abstract. Technical debt (TD), as a metaphor for utilizing quick workarounds to achieve short-term wins, is gaining attention in academia and industry. However, little is known about how companies pay off the accumulated TD, or why they chose to avoid this payment. The goal of this research was set to address this knowledge gap by gaining insight on TD payment practices, as well as on reasons behind the decisions to avoid debt payment in the Serbian IT industry. This research is a part of the InsighTD project—a globally distributed family of industrial surveys on TD—and as such it also amplifies the InsighTD reach and expands its knowledge base. A nationwide survey was conducted with practitioners from the Serbian IT industry, which was followed by a qualitative and quantitative data analysis. In total 79 valid responses were analyzed. Results show that TD is in most cases paid off by refactoring or by hiring specialized professionals, while the most common reasons why TD is not paid off include the lack of resources, complexity of the needed repayment work and the lack of management support. Results also suggest that payment of deadline-caused TD with additional work can generate additional TD injections due to tight schedule. This can motivate academics to conduct further empirical investigations while the practitioners can familiarize with practices for paying of the accumulated TD, as well as reasons for avoiding debt payment.

Keywords: Technical debt · Technical debt payment · Technical debt management · InsighTD

1 Introduction

Technical debt (TD) as a metaphor describes the use of quick workarounds during the software development process, that result in short term wins but can hamper both the future development and the maintenance processes [1–4]. For example, lack of coding standards can result with bad code, i.e., code debt and code smells [4, 5].

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 103–110, 2022.
http://doi.org/10.1007/978-3-030-97947-8_14

Software development can be viewed as a chain of various decisions, of which some start well before coding. All these decisions have an impact on the end product, and consequentially the creation of TD [6]. Dagstuhl Seminar on Technical Debt concluded that we need to better understand connections between non-coding activities and TD [1]. This would allow for a better balance of a delivered value of software with accompanying TD. Also, this conclusion consequently generates the need for further empirical investigations of TD.

The study presented in this paper addresses the aspect of TD payment practices and avoidance reasons in Serbian IT to contribute to a better understanding of this phenomenon. The study was done as a part of the InsighTD project[1] [7]. The objective of this study is to investigate what are the main TD payment practices and avoidance reasons in Serbian IT, and how does that relay to TD causes that were previously identified [8]. To accomplish this goal, three research questions were derived: (RQ1): What are the TD payment practices? (RQ2): What are the reasons for avoiding TD payment? (RQ3): How are TD causes related with payment practices and avoidance reasons?

This paper has the following structure: Sect. 2 presents the InsighTD project and introduces the related work on payment practices and avoidance reasons. Section 3 presents the research approach, while the Sect. 4.

2 Background

2.1 The InsighTD Project and Its Research Context

The InsighTD project represents a globally distributed family of industrial surveys on TD [7]. The main goal of InsighTD is to gain insight and acquire empirical evidence on the TD phenomenon to better understand it and to add to the TD knowledge base. InsighTD relies on the TD survey as the main research instrument and on various international teams of researchers that replicate the survey in the country that they are representing. At the time of writing this paper, researchers from 11 countries have joined the project. The survey was replicated in Brazil, Costa Rica, Chile, USA, and Serbia.

Various analysis from the collected data have already been conducted. These analyses include the analysis on the prevalence of TD, the identification of main causes and effects of TD [6, 7, 9], as well as the analysis on TD payment [10, 11]. A complete list of studies that are part of InsighTD project is maintained on the project's web page.

2.2 Technical Debt and Its Payment

Regarding TD payment in the context of InsighTD two studies have been published based on data from Brazil, Chile, Colombia and the United States. In the first study Freire et al. found that in 60% of cases TD was not paid off [10]. They also found that *Code Refactoring* is the most cited practice for TD payment, and that *Low Priority* and *Lack of Organizational Interest* are the most cited reasons for avoiding TD payment. The authors also identified categories that group TD payment practices and payment avoidance reasons and presented a TD payment map that encompasses all of these

[1] [Link accessed 13.07.2020] http://www.td-survey.com/.

categories [10]. The second study by Pérez et al. showed that it is possible to establish an association between main causes of TD and main practices to pay off TD. They found that eight out of ten causes of TD use refactoring as the main payment practice [11].

3 Research Approach

3.1 Study Context

This study was conducted by the Serbian InsighTD research team. Since the InsighTD relies on national teams to collect the data in their country of origin, the target population were professionals working in the Serbian IT industry. Some of the main demographic properties of the respondents include: (1) Expertise level: 78% Senior, 22% Junior (2) Role in development process: 66% Developer, 20% Manager, 14% Other. (3) Development approach: 50% Hybrid, 40% Agile, 10% Traditional. A more detailed presentation of the Serbian IT demographics, level of understanding of the TD concept, and TD conceptualization is presented in [6].

3.2 Survey Design and Execution

The survey, which is the main data collection instrument of InsighTD, is designed by the InsighTD core group [12]. Most of the core group members were experienced scientist from the Brazilian group, but the group also included scientists from other countries. The survey is based on existing scientific literature, but its design is also validated and updated based on several rounds of survey piloting. Before the actual survey execution, national teams were allowed minor modification of the survey to increase the quality of responses. Following this, the Serbian research team did the following adaptions: (1) several questions were translated to Serbian language, (2) participants were allowed to answer the open-ended questions in Serbian and in English. Survey was then set-up as an online survey, and it was available from February to November 2019.

The survey was distributed using the IT clusters in Serbia to geographically cover the whole country [6]. Also, the survey was distributed to authors' personal contacts who work in the IT industry who were in turn asked to further distribute the survey to their colleagues. These approaches aimed to ensure that the survey was disseminated to proper audiences across the whole country and to increase the credibility of the collected responses and the sample's representatives of the Serbian IT industry.

3.3 Analysis Method

The analysis relied on descriptive statistics and qualitative analysis of survey answers regarding the payment practices and avoidance reasons. Descriptive statistics provided various counts, that were presented in form of diagrams and charts. Extraction of payment practices and avoidance reasons, mapping of identified categories to existing map of categories and identifying new categories was done using the *coding technique* [13].

4 Results

Before addressing the RQs, it should be emphasized that by analyzing the survey answers it was possible to conclude if the TD items the participants named were paid off or if their payment was avoided. From the 79 participants that had valid examples from which TD types could be extrapolated 39% answered that the TD items have been paid off, 61% answered that the TD items have not been paid off.

4.1 TD Payment Practices (RQ1)

By analyzing the participants answers it was concluded that 29 participants elaborated how the debt items were paid off. Some participants even mentioned multiple ways that were used for TD payment. Figure 1 shows the top 10 payment practices that were cited by practitioners. As can be seen from Fig. 1 the most cited payment practice is *Refactoring*, followed by *Hiring specialized professionals*, *Design Refactoring* and *Reworking Parts of the System* (implies reworking a whole part of the system from scratch). Other less cited practices were: *Investing effort on TD repayment activities*, *Adoption of good practices*, *Improving the Team Collaboration*, *Acceptance of the cost of TD*, *Implementing additional workarounds* and *Negotiating deadline extension.*

Freire et al. identified and explained several categories regarding TD payment practices [10]. These categories were used to categorize the top 10 cited practices in this study. Figure 1 (left side) shows categories of TD payment practices (marked with *PC*). This figure shows that the 3 out of 4 of the most cited payment practices fall in the *Internal Quality Issues* category. This indicates that these practices can be used to address issues related to category. Other categories that were used were: *Organizational* (for categories associated with organizational decisions), *Methodology* (for payment practices associated with the development process that is used by the development team), *Development Issues* (for practices that are applied during the development of the software), *People* (for practices that are directly associated with professionals) and *Planning and Management* (groups practices associated with company management decisions).

4.2 TD Payment Avoidance Reasons (RQ2)

Participants that answered that the debt items were not paid off were asked to elaborate the reason or reasons why this payment was avoided, and 39 participants gave their insight on why the payment was avoided. Figure 1 (right side) illustrates the top 10 most cited TD payment avoidance reasons. The most dominant avoidance reason cited was *Lack of time* followed by *Cost*. Other avoidance reasons were: *Focusing on Short Term Goals*, *Low Priority*, *Insufficient Management View on TD Repayment*, *Complexity of the TD Item*, *Lack of Technical Knowledge*, *Lack of Resources*, *Customer Decision* and *Complexity of the Project*.

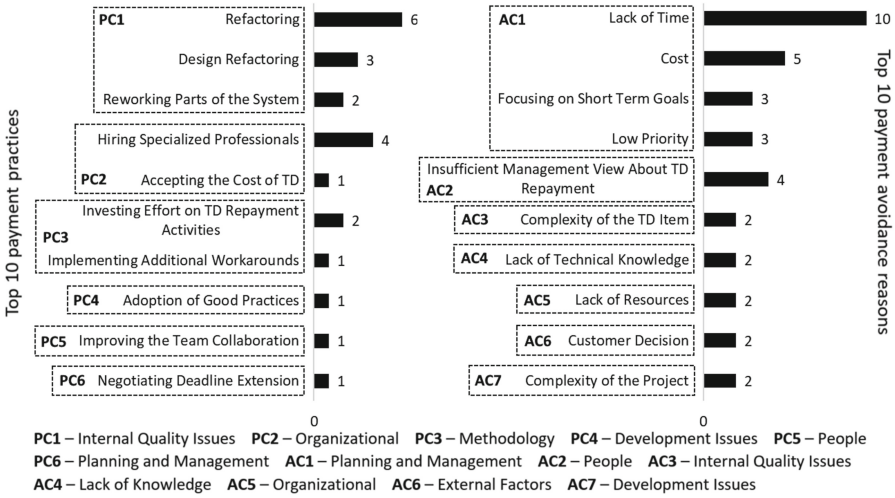

Fig. 1. Most cited TD payment practices and avoidance reasons (Categorized)

Identified payment avoidance reasons were categorized with the help of categories proposed by Freire et al. [10]. Figure 1 (right side) shows categories of TD payment avoidance reasons (marked with *AC*). The most dominant category was the *Planning and Management*, which groups 3 out of 4 most cited payment avoidance reasons. This finding indicates that the company management has the most to do with the decisions to avoid TD payment activities. Other identified categories were: *People* (groups avoidance reasons that directly relay to team characteristics), *Internal Quality Issues* (groups avoidance reasons that relay to system code and structure), *Lack of Knowledge* (groups reasons related to the lack of technical knowledge), *Organizational* (groups reasons that are related to organizational decisions), *External Factors* (groups reasons that are related to external factors like client decisions) and *Development Issues* (groups reasons related to issues tied with the development process).

4.3 Causes of TD and Their Relation with Payment Practices and Avoidance Reasons

To answer RQ3, the analysis approach from [11] was adopted thus the ten most cited causes of TD [8] were related with the identified payment practices and avoidance reasons. The relations are presented in Tables 1. The first column presents the causes of TD, last two rows show the practices and avoidance reasons and the sums showing the number of times the cause is related with the practice or the reason in survey answers.

Table 1 shows that causes of TD are mostly related to following practices: (a) *Accept the cost of TD*, (b) *Reworking parts of the system*, (c) *Design refactoring*, (d) *Refactoring* and e) *Hiring specialized professionals.* At least three observations can be made, first being the dominance of the practice to *Accept the costs of TD*. This practice is identified in 8 cases and it is related with 7 out of 10 causes that were observed. Possible interpretation for the acceptance of TD costs is that managers are unaware of the possibilities to

manage TD, and thus reduce the costs related to it. Another interpretation could be that the managers are unaware of the presence of TD. The second observation is about the relation of the *Deadline* cause with three related payment practices: *Reworking parts of the system*, *Design refactoring* and *Refactoring*. This suggests that in 60% of cases (9/15) the deadline-caused TD is paid by some type of rework on the existing artifact. The third observation highlights the relation between the *Lack of experience* cause and the refactoring activities. In 6/11 cases or 55%, *Refactoring* and *Design refactoring* were used to pay off the debt caused by the *Lack of experience.*

Table 1. Relation of causes with payment practices and avoidance reasons

Causes	Payment practices						Avoidance reasons				
Deadline	2	1	2	6	1	0	5	2	1	0	2
Ineffective project management	0	0	0	0	1	0	1	0	0	0	0
Lack of experience	2	4	1	0	1	0	2	0	2	0	1
Test not performed	0	0	0	1	0	0	0	0	0	0	1
Misconduct	0	0	0	0	1	0	3	1	1	0	0
Focus on producing more at the expense of quality	2	0	0	0	1	0	1	0	1	0	0
Lack of qualified professionals	1	1	2	0	0	0	0	0	0	0	0
Non-adoption of good practices	0	0	0	0	1	1	0	0	0	1	1
Lack of refactoring	0	1	1	0	0	0	0	0	0	0	1
Poor allocation of resources	0	0	0	0	2	0	0	0	0	0	0
	Refactoring	Design refactoring	Hiring specialized professionals	Reworking system parts	Accepting the cost of TD	Hiring an external company to resolve TD	Lack of time	Lack of tech. knowledge	Complexity of the TD item	Complexity of the Project	Customer decision
Sum:	7	7	6	7	8	1	12	3	5	1	6

Table 1 shows that the most common reasons why TD is not paid off are: a) *Lack of time*, b) *Customer decisions* and c) *Complexity of the TD item.* Two observations can be made, and the first is the relation between the *Deadline*, and the *Lack of time*, as the dominant reason for avoidance. This relation is identified in 50% cases (5/10) and indicates that *Deadline* as a cause and one of the main reasons for the *Lack of time*, can also be reasons for TD payment avoidance. The second observation is that two similar avoidance reasons, *Lack of technical knowledge* (3 cases) and *The complexity of TD item* (5 cases), together represent 8/27 cases or 30% of all identified relations. This may indicate that companies avoid paying the debt due to the lack of needed expertise.

The data presented in Table 1 is used to answer RQ3 and this data suggests that none of the cause can be related with a single practice or avoidance reason. If however, practices or reasons are observed as categories, that are presented in Fig. 1, following relations can be identified. Two causes, *Deadline* and *Lack of experience*, can be related with the *Internal quality issues* category that includes *Refactoring*, *Design refactoring* and *Reworking parts of the system.* The *Deadline* cause is also the only cause with

more explicit relation with the *Lack of time* avoidance reasons which suggests that tight schedules are the cause but also the reason why the TD is not paid off.

5 Discussion, Study Limitations and Future Work

The observations presented in Sect. 4, Causes of TD and their relation with payment practices and avoidance reasons, related the *Deadline* cause with *Internal quality issues* category of payment practices, and the *Lack of time*, as the dominant reason for payment avoidance. These observations reveal the potentially vicious circle which starts with the injection of TD due to already present tight deadlines in the development process. This TD will later be paid by rework which in practice means adding additional tasks to developers' task lists. If not properly planned, additional tasks may burden the developers' already tight schedule and close the vicious circle with the injection of new deadline-caused TD. Alternatively, the vicious circle may end by developer's decision to avoid the debt payoff due to *Lack of time.*

Our suggestion how to break the vicious circle is by applying the practice of *Hiring specialized professionals* or *Hiring an external company* that belong to the *Organizational* category. These two similar practices were identified in 19% (7/36) of cases as a practice to pay-off the TD. The arguments that support this suggestion include: (a) the developers' task list is not burdened with additional TD related tasks, since these tasks are completed by hired professionals. This way, the existing developers can continue their work without the injection of new deadline-caused TD. (b) The *Lack of technical knowledge* and the *Complexity of the TD item*, together with the *Lack of time* count 8 out of 10 cases or 80% of all avoidance reasons for deadline-caused TD. Assuming that hired professionals can successfully tackle the lack of technical knowledge, cope with the complexity of the TD item and that new workforce provides for more time for existing developers, it can be also concluded that hiring professionals has the potential to tackle large share of all reasons why deadline-related TD is not paid off.

This study has at least two limitations that should be recognized. First is that 79 responses are insufficient to provide the full representatives of the target population, which are the practitioners working in Serbian IT industry. Second is that the majority of the respondent's role is junior developer which makes this study bias towards their point of view. Regardless that these limitations may weaken the results, the authors' stance is that they still provide valuable insights, especially in the context of InsighTD project where they are aggregated with the results of other national teams.

Regarding future work, a cross-country analysis will be performed with the available data from the InsighTD project to increase the generalizability of the findings.

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The Path Towards Industry 4.0: A Comprehensive Methodology for Researching Serbian Manufacturing Industry: A Research Proposal

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Abstract. Since Industry 4.0 (I4.0) has become the guiding principle of manufacturing companies and policymakers in the majority of developed countries, many emerging economies have also adopted this concept to improve their national competitiveness and catch up with Western economies. The previous research presented that there are three main conditions for successful adoption and implementation of I4.0: technological, environmental, and organizational. Moreover, due to complexity caused by, e.g., cultural, political, economic, etc. differences, the conceptualization of such a methodology for emerging economies like Western Balkan countries is particularly challenging. Following the identified gap in lacking comprehensive research on the manufacturing sector's readiness for industrial digital transformation in Western Balkan region (e.g. Republic of Serbia), in this paper is presented a research proposal for researching the I4.0 readiness of the Serbian manufacturing industry.

Keywords: Industry 4.0 · Readiness assessment · Methodology · Manufacturing firms · Serbian industry

1 Introduction and Theory Background

The digital transformation of the economy and society, in general, is a relevant topic both in the scientific community and in the industrial environment. With focus on the manufacturing sector, digital transformation is often described as the "fourth industrial revolution", also known as I4.0 [1–3]. A European Commission report [4] argued that "a digital transition is underway across the global economy and industrial policy needs to integrate new technological opportunities such as cloud computing, big data, and data value chain developments, new industrial applications of the internet, smart factories, robotics, 3-D printing, and design". It is believed that these new technologies will lead to disruptive changes in the manufacturing sector in the coming years [5–7].

Since I4.0 has become the guiding principle of manufacturing companies and policymakers in the majority of developed countries, many emerging economies have also

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 111–119, 2022.
http://doi.org/10.1007/978-3-030-97947-8_15

adopted this concept to improve their national competitiveness and catch up with Western economies [8–10]. Transitional countries, like those in the Western Balkan region, have to be able to take full advantage of the technological opportunities from digitalization, having in mind the current gap between the developed and developing countries [11–13]. However, those countries are facing various structural, technological, and institutional hindrances that impede them from quickly catching up with more advanced countries [14–16]. More specifically, small and medium-sized manufacturing companies from the Western Balkan countries have serious problems grasping the overall idea of I4.0 and its specific concepts. Generally, the biggest challenge of these companies is to relate the concept of I4.0 to their business strategy and to determine their state of development regarding I4.0 [2]. Furthermore, those companies that invest in I4.0 technologies are engaged in a more complex environment than most of them are used to [12, 17]. This is causing their failure to identify an appropriate course of action in terms of further development towards digitalization strategies and prevents the integration of companies into international or national value chains and systems of innovation [13], which can either be supported by I4.0 or may be a pre-condition.

To overcome uncertainty and dissatisfaction and to promote the systemic interaction of manufacturing companies regarding digitalization, new methods are needed to provide guidance and support when aligning business strategies and operations [3, 9, 17, 18]. In the case of emerging economies, this methodology should be highly contextualized for the country in which the analyses are to be conducted [16]. Because of the complexity caused by, e.g., cultural, political, economic, etc. differences, the conceptualization of such a methodology for Western Balkan countries is particularly challenging [3, 8, 10]. Until now, there is a lack of research on the manufacturing sector's readiness for industrial digital transformation in this region. With conducted two *European Manufacturing Survey* (EMS) data sets (2015 and 2018), there is a basis for developing a valid methodology and for conducting reliable applied research in the Republic of Serbia [8, 10].

2 Objectives of the Research Proposal

The main objective of the research proposal is to boost the implementation of I4.0 in the manufacturing sector of the Republic of Serbia through lightening the evolutionary path of the digitalization process. Thus, the research will help Serbian companies grasping the overall idea of I4.0 and enabling their integration into international or national value chains and systems of innovation. In the context of the main objective, specific activities are:

(1) To **conduct a quantitative analysis using the methodology for general readiness assessment** and potential for the implementation of the elements of I4.0, to determine the Serbian level of maturity **based on the existing European Manufacturing Survey database**;
(2) To **develop a methodology for an in-depth readiness assessment of I4.0** with a specific conceptual approach for analysing manufacturing companies profiles concerning I4.0 in the Republic of Serbia;

(3) To **analyse the in-depth readiness assessment of Serbian companies** and thereby **to map the Serbian manufacturing industry in terms of the sophistication on the path to I4.0.**
(4) To **identify the barriers to implementing digital technologies and adopting I4.0.**
(5) To **improve the conditions for the digitalization of manufacturing companies in the Republic of Serbia** by developing a toolbox of policy recommendations for data-driven digitalization strategies that enable their integration into international or national value chains and systems of innovation.

3 Methodology

To obtain a comprehensive picture of the potential and perspectives of I4.0 in the Republic of Serbia, a multi-dimensional approach will be applied (Table 1). Multi-dimensionality, in this frame, refers to different analytical levels on the one hand and to diverse data and information sources on the other hand.

Table 1. Research plan: methodology, objectives and expected results.

Method			Objective	Results
Quantitative survey	Method **1**	European Manufacturing Survey Data Bases 2015, 2018	General readiness analysis; Benchmarking with other EMS countries	**Descriptive statistics**; Benchmark report
	Method **2**	Survey-based on a special FH-ISI methodology developed for assessing I4.0 readiness	In-depth quantitative readiness analyses; Potential analyses	In-depth **descriptive statistics; industry mapping** Report on **Potentials**
Qualitative survey	Method **3**	Interviews in manufacturing companies based on FH-ISI methodology	Exploring and analysing barriers on the path of I4.0	Report on **barriers**; Set of **policy recommendations**

All those sources and dimensions will feed into the synoptic analysis of the current situation of I4.0 in the Republic of Serbia, particularly the readiness of Serbian manufacturing sectors for I4.0. This synopsis then serves as an analytic base for developing well-founded policy recommendations.

3.1 Method 1: General Readiness Assessment Based on EMS Data

To assess the general readiness to digitalize, it is of particular interest whether companies use and combine several technologies at the same time or in which technological

fields companies are increasingly active. For this purpose, the Fraunhofer ISI developed an I4.0 general readiness assessment methodology that combines the number of digital technologies used with three technological fields and thus provides information on the digitalization readiness of individual companies [19]. The Fraunhofer I4.0 readiness assessment approach is exclusively focused on technology. It is based on seven digital technologies: software system for production, planning and control, digital visualization at the work place, digital data exchange with customers/suppliers, techniques for automation and control of internal logistics, real-time production control system, mobile devices for programming and operation of plants and machines; and product life cycle management systems. These are combined into the following technology fields: Digital Management Systems, wireless human-machine communication, Cyber-Physical Production System (CPS) related processes. While the first two technology fields tend to cover digital basic technologies and still have a clear distance from I4.0, the third technology field already contains the first approaches of digitally networked production. Using this grouping, those companies that are closer to I4.0 are those who use and combine digital technologies in all three technology fields and use several of the CPS-related processes. By contrast, companies that only apply digital technologies in one or two technology fields are less willing to work for digitally networked production in the sense of I4.0.

In this research, the basis for conducting General readiness assessment analysis represents the database built within the project "European Manufacturing Survey" (EMS) [20] carried out in the Republic of Serbia in two survey rounds, in 2015 and 2018 [9, 10]. The surveys used the scientifically based EMS methodology developed by EMS Consortium consisting of experts from research institutes and universities from and across Europe since 2001 and led by the Fraunhofer ISI. On a company level, EMS surveys the utilization of techno-organizational innovations in manufacturing and thereby possible performance increases in the manufacturing sector. EMS aims to utilize a core questionnaire, in the respective language of the country, in all partner countries and thus survey internationally comparable data allowing for internationally comparative analyses. EMS covers a core of indicators on the innovation fields "technical modernization of value-adding processes", "introduction of innovative organizational concepts and processes", and "new business models for complementing the product portfolio with innovative services". The questions on these indicators have been agreed upon in the EMS consortium and are surveyed in all of the participating countries. In most countries, EMS is carried out as a written survey on the company level. For preparing multinational analyses, the national data undergo a joint validation/harmonization procedure. Analyses of the national data set of EMS serve to improve the scientific state of knowledge and policy counselling for evaluating technological and economic measures as well as information of associations and trade unions in the participating countries. Moreover, research cooperation executes multinational comparative analyses. Furthermore, EMS data constitute the basis for an informative performance benchmark offering companies the opportunity to benchmark themselves nationally as well as internationally with other companies.

3.2 Method 2: In-Depth Readiness Assessment Based on a Tailor-Made Methodology

In the second phase, using data from general readiness assessment analysis in combination with an extensive review of relevant scientific literature and the consultations with the experts in the field of digitalization and I4.0., an in-depth readiness assessment methodology will be designed and developed specifically for the Serbian manufacturing industry following the approach of Horvat et al. [2]. In contrast to the general readiness assessment methodology, which focuses solely on technology-based analyses, an in-depth readiness assessment methodology is supposed to introduce other non-technological aspects. Technological advancements need to be embedded in the companies' structures and processes, as well as their "culture" [2, 21]. To give an example, the successful introduction of new (network-based) technologies might require changes to the existing organizational structures or qualification measures for in-house staff [2, 17].

Having in mind all the above, this part of the research consists of several key phases. As a part of the methodology development process, an extensive review of relevant literature sources and previous studies will be conducted. This will include several activities: identification of relevant literature sources and databases (electronic and print sources, etc.), the definition of key search terms, based on research goals, as well as the definition of search strategies and mechanisms, the identification and selection of relevant and primary/secondary studies, the inclusion/exclusion of studies based on selection criteria (quality appraisal), and finally a synthesis of literature review findings.

Based on the literature review as well as previous experiences of the Fraunhofer ISI, assessment tool will be designed and developed, which will be used for data collection in the in-depth readiness assessment analysis. Thus, manifest variables identified as measures of their respectful latent structures will be operationalized, in the form of the questionnaire items, along with control variables. Such a questionnaire will be a subject of face and validity assessments with Serbian and German companies and research experts. Face validity could result in improvement recommendations, and therefore, if necessary, such corrections will be made in a timely manner. After the initial assessment of the research instrument, broader distribution of the questionnaire to potential respondents comes at the next phase. Thus, the research population and sample size will be calculated and determined. This phase will be done according to recommendations for sampling techniques elaborated in Bartlett et al. [21]. The main result of this phase will be a developed methodology for in-depth readiness assessment characterized by different "degrees of readiness for I4.0" which will be the foundation of a new methodology. Following, the developed assessment tool will be implemented in the form of a survey in the Republic of Serbia. After the estimation of the research population and sample size, the data gathering procedure will be performed using the methodology explained in Dillman et al. [22]. This approach consists of a series of follow-ups and reminders to provide a higher response rate. Also, this approach will give some basic remedies regarding sample and respondents' biases. In short, randomly selected companies from the sample will be contacted by telephone to identify an appropriate respondent in each company. Employees responsible for production activities will be contacted as the most appropriate respondents because of the scope of the overall questionnaire, which is mostly related to production processes. After gathering information about the person responsible for

production activities, the questionnaire will be sent out directly to that person by post or e-mail. This approach was previously used in conducting the EMS survey data collection when the validity of the methodology was confirmed two times through high response rates (about 35%), which led to a successful collection of a representative sample of the population. Data collected in the previous step will be used for conducting in-depth readiness assessment analysis by the developed methodology in phase 2, which results will be the basis for assessing the specific characteristics of Serbian manufacturing companies in the area of digitalization. Those obtained characteristics will be implemented to classify companies according to the developed methodology as well as to map the industry in terms of I4.0 sophistication.

3.3 Method 3: Qualitative Analysis of Barriers for Uptake I4.0 in Serbian Industry

To identify and understand the issues for implementing digital transformation in the Serbian manufacturing sector, an additional qualitative study based on interviews with manufacturing companies and other stakeholders and experts, will be designed and conducted [23, 24]. For this explorative analysis, a conceptual framework will be developed relying on the systematic literature review and the main categories of the assessment tool developed and implemented in the in-depth quantitative analysis [25]. This conceptual framework will serve as the basis for designing interview guidelines. Between 10 and 15 expert interviews will be conducted with manufacturing companies covering the main sectors in the Republic of Serbia, various company sizes and all three regions, Belgrade, Vojvodina, and Central Serbia. In addition to interviews in companies, also is planned to conduct interviews with experts and stakeholders, e.g., researchers, politicians, consultants, intermediary organizations. All interviews will be recorded, transcribed and the data will be analyzed based on the developed conceptual framework. The results will be described and interpreted in the final report and will serve as the basis for developing policy recommendations for the modernization of the Serbian industry as well as for potential I4.0 strategies in the Republic of Serbia.

4 Expected Results and Conclusion

Assessing and mapping manufacturing companies in the Republic of Serbia in the context of their level of readiness for I4.0 will provide a novel insight for interdisciplinary researchers into possibilities for the monitoring of industrial modernization in emerging economies, with a particular focus on the Western Balkan region. Moreover, it will help in the modernization of manufacturing companies in the Republic of Serbia on their path to a higher level of digitalization (i.e., industrial engineering, mechatronics, mechanical engineering, electrical engineering, logistics, etc.). Besides the classical, solely technology-focused research in this field, the research will also significantly contribute to non-technological areas. It will point to the fields of human resources and competences in digital surroundings as well as the improvement of organizational and management concepts, including new business models and digital innovation. Thus, it will contribute to the establishment of interdisciplinary and multidisciplinary scientific

research groups in the Western Balkan region and Germany, facilitated through new knowledge arising from this research.

The research will focus on involving universities and other research organizations in the main activities, as well as engaging with manufacturing companies (SMEs and large enterprises) and public policy bodies as primary stakeholders in the I4.0 related activities. Regarding the implementation of I4.0 in the Republic of Serbia, this research could help the government to take on a leading role and be in the frame of providing modernization support instruments for the industry. On the other hand, the main challenges for Serbian companies in terms of their digital transformation are the reduction of uncertainty related to financing the respective projects, the understanding of medium- to long-term benefits of digitalization, and the effective qualification of employees. Overall, the research will help the Serbian manufacturing sector to increase regional and international competitiveness and thus having a positive effect on economic stability, growth, and quality of life.

Through joint research activities and the cooperation between the Fraunhofer ISI and the University of Novi Sad, Faculty of Technical Sciences, the engagement of young researchers from both sides will result in building a new research and knowledge base. Therefore, various research methods will be used, such as systematic literature reviews, the development of research instruments (questionnaires), and systematic data collection, different statistical analysis, writing of scientific papers for high-level journals and international conferences, PhD theses design, and focused scientific as well as practice-oriented reports. Hence, the knowledge transfer will contribute to the quality of the research work, particularly by young researchers, in both countries and thus improving their international visibility and competitiveness.

Funding. This research is supported and partially financed by the Science Fund of the Republic of Serbia under the grant Serbian Science and Diaspora Collaboration Program: Vouchers for Knowledge Exchange, (PI4SM) "The Path Towards Industry 4.0 – Serbian Manufacturing".

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Analysis of Influential Elements of Entrepreneurial Ecosystems

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Abstract. It is evident that change is ever-present in today's uncertain market conditions. The countries that recognize this are predisposed to reaching significant economic growth and development. Furthermore, it is important for all countries to acknowledge that the concept of growth and development has changed, compared to what it used to be in the beginning of the 21st century. Economy is now going through structural changes, from the, until now, dominant "mass economy" based on mass production and use of energy resources, to the "economy of knowledge" in which there is a market shift towards the factor of knowledge. This poses one of the most crucial challenges the countries around the world have been facing in the past decade and it is a challenge closely related to the growing importance of non-physical capital, i.e. human and intellectual capital in creating opportunities and wealth. The last few decades have seen an increase in entrepreneurial endeavors, which has certainly helped to tackle, overcome and benefit from the changes in uncertain environments. Hence the widespread understanding that the success of the economy of knowledge greatly depends on entrepreneurship, which is one of the main initiators and motors of economic growth and development. The notion of entrepreneurship has evolved as well, into a more holistic and multifaceted understanding of entrepreneurship, where there is a growing opinion that sees "ecosystems as supporters of entrepreneurship". The purpose of this paper is to analyze the influential elements of entrepreneurial ecosystems, through a theoretical overview, during the entire life cycle of a new venture.

Keywords: Entrepreneurship · Entrepreneurial ecosystem · Influential elements of entrepreneurial ecosystems · Competitiveness

1 Introduction

Entrepreneurship plays a significant role in economic development, however, its activities do not take place in isolation from the local context in which entrepreneurs operate. A holistic approach to entrepreneurship and innovation has become a new trend in observing these concepts. When we look back at research of the relationship between entrepreneurship and innovation, for almost two decades the studies have been focused

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 120–127, 2022.
http://doi.org/10.1007/978-3-030-97947-8_16

on environments that influence innovation [1, 2]. In latter reasearch, it was postulated that innovation is comprised of two chief elements - institution and enterprise [3]. The latest trend in studying innovation and entrepreneurship favors the multifunctional and multidisciplinary approach [3, 4], where various literature contributes to the holistic view of entrepreneurship [5–7]. In other words, studying innovation and entrepreneurship has not been focusing on traits of an individual, their personality and behaviour, which are all important factors in understanding entrepreneurial activity as a whole. The holistic approach has become and new step in defining entrepreneurial policies [4, 8–10], and it focuses on the role of entrepreneurial ecosystems and related activities, where these ecosystems are adaptable and sustainable. A holistic approach advocates the exploration of entrepreneurial activity, as an individual behavior of entrepreneurs embedded in the local context, rather than focusing on entrepreneurial activities in isolation. Creating a local context is of great importance for encouraging entrepreneurship and economic development. On the one hand, the action of an individual is the result of attitudes, aspirations and opportunities provided in a particular context, related to where the individual lives and works [6]. On the other hand, the local context influences the start-up of a company and the speed in which it develops [11]. Researchers have recognized the importance of such holistic approach, as it gives them greater access to information, networking, finance, infrastructure and other elements of an entrepreneurial ecosystem, which will be described in more detail below.

2 Entrepreneurial Ecosystems

Entrepreneurship is in a positive correlation with economic growth and development. Entrepreneurs are people who innovate, they are everywhere, in every society, and they find ways to place their products on the market. In case that somebody wants to become an entrepreneur, he should start up a new business or establish a new business unit in a different, innovative manner compared to the existing one practice. Those are conditions which initiate the need to implement entrepreneurial management and appropriate education in this area [32]. Before defining an entrepreneurial ecosystem, it is important to define the terms system and ecosystem. A system is a set of organized interactive and interdependent subsystems, which function together as a whole, to achieve a specific purpose, while an ecosystem is a purposeful network of dynamic, interactive systems and subsystems that have a variable set of activities in today's context [12]. The purpose of the research lines launched in this context is not only to determine the abundance of certain key factors or resources that shape economic performance, it is also the way in which entrepreneurial activity is organized and configured within a certain geographical area. The entrepreneurial ecosystem is a new way of contextualizing all of the complex social systems. The dynamics of entrepreneurship do not take place in isolation from the local context in which entrepreneurs operate [4]. In other words, individual entrepreneurial activity and contextual factors, which are of great importance, are also recognized. On the one hand, an individual's action is the result of attitudes, opportunities and aspirations in a particular context, in which the individual acts, and on the other hand, the local context affects the start-up of the company and the speed in which the company develops [13]. In their research, Miller and Acs (2017) raised the question that arises in the analysis of

entrepreneurial ecosystems - what is the appropriate unit of analysis of entrepreneurial ecosystems? They raised the question of whether the entrepreneurial system can be one country, city, region or something smaller, such as an incubator. What is an important characteristic of the modern entrepreneurial ecosystem is that it offers characteristic opportunities, which include available resources, freedom and diversity, which at the same time create opportunities that encourage entrepreneurship and innovation [28]. Acs (2014) defines entrepreneurial ecosystems as "Dynamic, institutionally embedded interactions between entrepreneurial attitudes, abilities and aspirations of individuals, which drive the allocation of resources, through creation and operation of new ventures" [4]. Stam (2014) also has an insight into the entrepreneurial ecosystem and views it as an "Interdependent set of actors, arranged in such a way as to enable entrepreneurial action" [5]. Audretsch (2017) defines the entrepreneurial ecosystem as an important interaction between the contextual domain of an ecosystem and individual decision-making, which is guided by attitudes and perception of the context [14]. Based on the above definitions, it can be concluded that entrepreneurial ecosystems are geographically limited and that the same elements of entrepreneurial ecosystems differ from the observed geographical area. The first is that entrepreneurship is rooted in actions taken on the basis of environmental incentives. The second is that individual entrepreneurial action is influenced by institutional framework conditions, and the third is that entrepreneurial ecosystems are complex, multi-layered structures, in which many elements interact, that the elements are different depending on the observed area and that there is no size that fits all analyses.

3 Analysis of Elements of an Entrepreneurial Ecosystem

There are several directions when reasearching an entrepreneurial ecosystem. In this paper the focus will be on the Global Entrepreneurhip Index powered by GEI research [15]. In addition to this, a very important research of entrepreneurial ecosystems is The Regional Entrepreneurship and Development Index - Measuring Regional Entrepreneurship [6] which differs from the aforementioned research because it analyzes entrepreneurial ecosystems in different regions. The REDI research has made significant progress in taking a holistic approach to the analysis of entrepreneurship and innovation. In addition to the stated directions in the research of entrepreneurial ecosystems, a very important research is also the one set by Stam and van de Ven [31]. They view the entrepreneurial ecosystem as a driver of successful entrepreneurship and the institutional environment and resource endowments. Identifying the main elements of an entrepreneurial ecosystem in the GEI survey aims to measure the quality of entrepreneurship in the observed country and the scope and quality of support to the entrepreneurial ecosystem. The elements of entrepreneurial ecosystems are very complex, and one of the most important reasons for this is the fact that entrepreneurship plays a different role at different stages of development. The GEI research views an entrepreneurial ecosystem through three major entities - entrepreneurial attitudes, entrepreneurial skills, and entrepreneurial aspirations. These three large units are broken down into 14 elements of an entrepreneurial ecosystem, each of which contains two variables - the individual variable and the institutional variable, in order to satisfy the aspect of entrepreneurship at the micro and macro level. According to the GEI methodology, elements of entrepreneurial

ecosystems are divided into three groups – entrepreneurial attitudes, entrepreneurial skills and entrepreneurial aspiration. In the following, each of the listed elements of entrepreneurial ecosystems, according to the GEI methodology, will be explained in more detail.

3.1 Entrepreneurial Attitudes

Entrepreneurial attitudes give us insight into how a country thinks about entrepreneurship. According to the GEI research [15], entrepreneurial attitudes include five elements of an entrepreneurial ecosystem. The first element is the perception of opportunities, viewed from the aspect of property rights and regulatory strains, which could potentially limit the use of a perceived entrepreneurial opportunity. When looking at property rights, as defining factors in the perception of possibilities, it can be said that they pose an assessment of an individual's ability to accumulate private property, which is secured by clear laws that a country applies [16]. In other words, it is an enforced guarantee regarding the property rights that individuals have when they are obtaining positive results, based on the use of a successful business opportunity, without anyone else having the opportunity to confiscate or steal that right from them. The second element is the skill of starting up. Start-up skills can be crucial to exploiting perceived opportunities. Start-up skills depend on self-esteem of a population and their ability to start a successful business, through the prism of skills and the quality of education [17]. The third element is the ability to accept risk. When entrepreneurial traits are observed in the literature, the fear of failure is one of the biggest obstacles to exploiting a perceived market opportunity. Although risk represents the possibility of unforeseen and unintended consequences, the fear of accepting risk and the fear of failure can not only slow down entrepreneurship, but can even negatively affect a potential business start-up. The fourth element is networking. Networks represent the presence of social networks to which entrepreneurs, advisors, investors connect, and such networks enable a free flow of knowledge and skills. Networking is a combination of an entrepreneur's personal knowledge with their ability to connect with others locally, regionally and globally. Networking is an important component of a successful entrepreneurial venture. Those entrepreneurs who have a more developed network are more successful because they can identify more opportunities and can access better resources. Networking and social media are the latest trend in the modern business world and are significantly changing the way people present themselves as well as the way they do business. When dealing with social media, companies need to know that they have taken a step back. Regular education is needed, as well as following trends and examples from practice in order to progress [18]. Finally, the fifth element of entrepreneurial attitudes is cultural support. Cultural attitudes support entrepreneurial activity, risk-taking and innovation. High levels of corruption can undermine the high status and permanent career paths of legitimate entrepreneurs. Cultural support reflects how a country's residents view entrepreneurs in terms of status and career choices and how the level of corruption in the country affects them. If there is no strong cultural support in the country, even the best entrepreneurs can still opt for a traditional, instead of an entrepreneurial profession [19]. This is precisely the reason why, cultural support, that is, acceptance and encouragement of entrepreneurs, represent very important parts of entrepreneurial attitudes.

3.2 Entrepreneurial Skills

Entrepreneurial skills provide answers to questions of what can be done and whether there actually exist the necessary skills to transform an idea into practice. The focus of entrepreneurial skills is on measuring the important characteristics of entrepreneurs and on reaching a potentially high growth of a company. The first element of this group is seizing the opportunity to start an entrepreneurial venture. Motivation is defined as the use of entrepreneurial opportunity, in order to take advantage of a good opportunity, to increase income or to meet personal goals [20]. Entrepreneurial motivation is also influenced by the favorable business environment, i.e. the freedom to start and do business. The second element is the absorption of technology. As we live in a modern economy, one that is based in knowledge, information and communication technologies play a vital role in economic development. What is very important in the analysis of this element is that not all the sectors provide the same chances for survival of a company or its potential growth. The third element is human capital. As aforementioned, the knowledge economy is focusing its trends on investing in human capital, as opposed to the mass economy, which is centered around materials and energy. Investing in human capital can increase production capacity more than any other factor of production. Since investments in human capital are characterized by an increase in the rate of return on investment, they are key to long-term economic growth. Investing in human capital is vital for innovative and high-growing ventures because they require educated and experienced people, who are prone to continuous learning and improvement. The need for continual improvement is the imperative for each enterprise in order to maintain its competitiveness in an increasingly changing market environment [27]. As expected, it is difficult to invest in human capital, but this sort of investment is profitable in the long run because it increases the quality of human capital and has a positive impact on a company's business and its growth potential [21]. The last element that is included in this group is competition. Companies facing a low level of competition could certainly grow faster than those facing a lot of competition [16]. If powerful business groups dominate the market, it is likely that the entrepreneur will give up pursuing his business idea [22].

3.3 Entrepreneurial Aspirations

Entrepreneurial aspirations speak about entrepreneurial desires and ambitions. The first element in this group is product innovation. Some products play crucial roles in economies of countries around the world. Developed countries were once the greatest source of new products, but today, developing countries produce such outputs, but in a dramatically more affordable fashion than their Western counterparts. Absorption of a new product is a measure of a country's potential to generate new products and to adopt or imitate existing products. Technology transfer is a complex measure that signals if a business environment allows for the application of innovation needed to develop new products [21]. The second element is process innovation, which considers the importance of applying and/or creating a new technology, which is also an important feature of companies with high growth potential. However, most entrepreneurial companies do not merely apply new technology, they create it. After that, the third element is high growth. High growth is a measure that represents the percentage of high-growth companies that

intend to employ at least 10 people and plan to grow by more than 50% in the period of 5 years, where the sophistication of business strategy and venture capital financing play a major role. Business strategy is very important for the potential of reaching high growth, because it refers to the ability of companies to follow distinctive strategies, which includes differentiated market positioning and innovative means of production and service delivery [16]. The fourth element is internationalization, which is believed to be the main growth defining factor. Exports are very important for internationalization, as well as institutions. Exports require all the capabilities that a company needs, in order to enable production that does not exclusively supply the domestic market. On the other hand, the institutional dimension and openness of a country toward international entrepreneurs is also very important. Internationalization is an element designed to identify the degree to which entrepreneurs in a country are internationalized, which is measured by the export potential of an enterprise, followed by control over the extent to which a country is able to produce complex products for foreign markets [23]. Finally, the last element of this group is venture capital. The availability of venture capital, especially when it comes to core capital, and not debt capital, is a prerequisite for meeting entrepreneurial aspirations, which goes beyond the entrepreneurial personality and financial resources [24]. Funding opportunities are often seen as the most important aspect of exploiting the potential for high growth.

4 Conclusion

Entrepreneurial ecosystems are resource allocation systems that facilitate the allocation of resources to serve a productive purpose and use. Entrepreneurial ecosystems are enabled by the widespread trend of digitalization, which constantly opens up opportunities to re-examine value-creating activities through business model innovations. Precisely because of this feature, entrepreneurial ecosystems are the key driver of progress towards a digital economy [25]. As can be concluded from the above, digitalization and entrepreneurial ecosystems are interconnected. Digitization connects entrepreneurial ecosystems at the global, national, regional, industrial and/or corporate levels [29]. Another very important element that affects the development of entrepreneurial ecosystems is certainly university support, which has become a widespread phenomenon around the world. Such organizations have a great influence on the development of entrepreneurship. Given the growing importance of student firms, it has been found that university entrepreneurial projects can have positive effects on the development of new products, and thus entrepreneurial ecosystems [30]. Entrepreneurial ecosystems are an important subject of policy, but also a very challenging subject, which is observed as a systemic phenomenon, the dynamics of which are not easily reduced to actions at the company level and require a holistic approach [26]. In understanding entrepreneurship, it can be said that it is similar to other social beings. Entrepreneurship is a multidimensional phenomenon, the exact meaning of which is very difficult to determine precisely. What is even more demanding is how we measure entrepreneurship. Over the decades, certain indicators of entrepreneurship have been created, however, none have been able to reflect the complex nature of entrepreneurship and provide a credible explanation of its role in development. The GEI research is one of the first surveys, the result of

which is a complex index that measures entrepreneurial ecosystems at the national level, which demonstrates the multiple nature of entrepreneurship. As already stated, the GEI research places emphasis on both individuals and the institutional environment, because only in this way can accurate assumptions be obtained for the analysis of elements of entrepreneurial ecosystems. Finally, after analyzing the elements of entrepreneurial ecosystems and determining the degree of success of each element, it is recommended to focus primarily on the weakest element of an entrepreneurial ecosystem, in order to achieve the greatest profit. However, in order to improve the overall performance of an entrepreneurial ecosystem, work must be done on all the poorly rated elements of that entrepreneurial ecosystem as this is the only way to improve it effectively. As discussed in the paper, the GEI research is not the only survey that provides indicators for measuring entrepreneurship, but it certainly stands out as a valuable tool that measures and analyzes entrepreneurship at the country level. The proposal for future research is a direction towards the research of personal factors of individuals, because these are the factors that drive innovation, then implementation, and finally the growth of entrepreneurial ecosystems.

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Metal Artefact Reduction from CT Images Using Matlab

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Abstract. Artefacts are common threats in computed tomography images, which deteriorate the image quality and limit the diagnostic value of the examination that results in lower treatment outcomes. Degradation of CT image quality is happening due to the metal implants, which are shown as dark and bright streaks across the image. Beam hardening and photon starvation are main reasons for presence of artefacts in CT images caused by dental fillings, surgical clips, artificial hips etc. Metal artefact reduction methods have been one of the most common subjects of recent research in the field of medical imaging. The aim of this paper is to propose a methodology for artefacts reduction using Matlab, which benefits the suppression of artefacts in the image domain. Reconstruction of images is based on thresholding techniques and manipulation of pixel data to accomplish the correction of CT images. Results show that it is possible to reduce streaking artefacts and thus enhance medical image quality.

Keywords: Computed Tomography (CT) · Metal Artefact Reduction (MAR) · Medical imaging · Otsu's method · Image segmentation · Threshold mask

1 Introduction

The role of medical imaging in predictions, patient diagnosis and treatment of disease is indisputable owing to their conveyance of reliable anatomical information. Computed Tomography (CT) uses X-rays to generate cross-sectional images of internal organs, bones and soft tissues with the aid of computer processing. Numerous types of artefacts are present in the CT image domain due to the high probability of errors. Issues appear when image derived from numerous X-ray projections contains many measurements that are back projected to reconstruct the image. Artefacts could be determined as misrepresented content of the medical image that is not present in the real and original object [1]. As a consequence of aforementioned, artefacts can lead to misdiagnosis if they are not properly identified and later rectified.

Presence of metallic implants with high atomic number in the patient's body leads to deterioration of CT image quality. High-density objects such as dental fillings, prosthetics, surgical clips and artificial hips contribute to the loss of projection data in the form of bright and dark streaking artefacts.

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 128–134, 2022.
http://doi.org/10.1007/978-3-030-97947-8_17

Metal artefacts are caused by a combination of mechanisms and physical phenomena, including photon starvation, beam hardening, Compton scattering, noise, patient-induced artefacts [2, 3] etc. Most commonly reviewed and encountered in the literature are beam hardening and photon starvation [4]. Photon starvation artefacts are caused by a deficit of photons reaching the detector. X-ray beams become attenuated and consequently insufficient photons reach the detector and result in strong streak artefacts. Whereas, beam-hardening artefacts appear as cupping, streaks or dark bands between several dense objects, such as bones or metals. Increase in the mean energy of the X-ray beams occurs as beam passes through the scanned object. Lower energy photons of the polychromatic X-rays are preferentially attenuated, whereas higher energy photons are harder to be absorbed. As an outcome, beam is diminished in intensity that lead to the representation of the scanned object with edges brighter than the centre despite the fact it consists of the same material.

The rest of the paper is organized as follows: Sect. 2 contains related work, while Sect. 3 describes the method used for metal artefact reduction using Matlab in the image domain. Section 4 presents achieved results with discussion. Finally, Sect. 5 hold the author's conclusion.

2 Related Work

Artificial metallic implants, which are present in the scanned object, evoke streaking. If it is possible before the scan procedure, removable objects such as jewellery are taken off. Non-removable metallic items demand further corrections with increasing radiation or adjustment of gantry angle. If these methods are insufficient to overcome disruptions, there is an obvious need for algorithms to be implemented.

Metal artefact reduction (MAR) methods represent the topic of contemporary research and therefore various approaches have been proposed for the elimination of artefacts actuated by metallic implants. A variety of algorithms are developed and can be classified into two groups: implicit and explicit methods [5]. Implicit methods include attempts to reduce artefacts without the aid of algorithmic mathematical methods and they are quite limited in applicability. On the contrary, fundamentals of explicit methods are mathematical algorithms and represent the focal point of researches. Explicit methods include approaches regarding sinogram domain, image domain, iterative reconstruction algorithms and hybrid techniques.

Corrections in the sinogram domain are distributed into two groups: interpolation-based sinogam and non-interpolation-based sinogram corrections [5]. Several steps such as isolating affected regions in sinogram, while using interpolation techniques and later reconstruction are habitual operations used in the first scenario.

Image-based approaches include replacement of the corrupted pixels, generally by a constant value. One of the proposed models include image segmentation, image inpainting to fill corrupted parts and projection completion [6]. Differentiation between the metallic objects and surrounding tissues represents a challenging task in general, but the proposed algorithm accurately reconstructs the image.

Iterative image reconstruction methods include algebraic and statistical techniques. Algebraic reconstruction technique (ART) and maximum likelihood-expectation maximization (ML-EM) [7] require not only high computational time but also introduce subsequent high costs.

Hybrid techniques represent the integration of different approaches intended to overcome deficiencies in individual implementation of methods. Hybrid MAR method is proposed in [8], as the consolidation of various methods where research group concluded that specific hybrid method showed superior outcomes compared to linear interpolation and forward projection-based methods.

In the past decade the widespread use of machine learning techniques is present regarding numerous implementation such as [9, 10], where proposed models are used for detection of inaccuracies in the credit card frauds or recognition of vehicle's license plates. In the medical imaging domain deep learning, as a part of machine learning, is used for image analysis with learning algorithms, such as neural networks. Among prior mentioned approaches regarding MAR methods, in recent researches subject matter represents the usage of convolutional neural network (CNN) and deep learning for image reconstruction and metal artefact suppression.

Deep-learning-based method combat the problems in the projection data domain, metal implants are regarded as missing data while deep network is used to complete such data in the projection domain. Computational efficiency and simple adoption in scanners represent a major benefit regarding this approach [11]. Hegazy *et al.* implemented U-Net for metal segmentation in projection domain to improve artefact reduction performance in dental CT [12]. Fusion of two CT images, original raw projection data and corrected one, was forward-projected and fused data substituted metal regions in the original projection data. This kind of segmentation demonstrated better performance than the conventional segmentation methods in the image domain.

Zhang *et al.* also propose the concept of convolution neural network in medical imaging and artefact reduction where the performance in terms of artefact reduction and maintenance was tested on both real and simulated data [13]. Another work represents usage of simple network with three convolutional layers and results reflect some limitations regarding loss of projection data in the affected image region in addition to remained mild artefacts [14].

Depending on the data that is used for artefact reduction methods in CT, apart from the CT data, corresponding data from tri-modality imaging systems, dataset of positron emission tomography (PET), magnetic resonance MR and CT data, is also used. Dataset from tri-modality system, specifically corresponding MR image is used as additional information in [15] reduction method that shows promising results for the future implementation in medical imaging. Additionally, in some instances simulated artefact data serve as input for methods while real data without artefacts serve as ground truth, to ensure whether the MAR algorithm has valid or invalid outcomes.

3 Methods

The present study aims to represent the implementation of the methodology for suppressing artefacts in dental CT imaging using methods for detection artefacts and later rectification. The proposed algorithm comprises of two essential steps: detection of metal artefacts and substitution of corrupted pixels.

The detection of artefacts is accomplished using Otsu's thresholding technique for image segmentation, that is widely used for extraction relevant information from the image. For this step, Otsu's method is used for image segmentation that executes conversion of digital grey level image to binary image depending on the threshold values [16]. Two classes of pixels are present, foreground and background pixels of the image where is intended to isolate region of interest from the background. The original CT image has diverse dental artefacts that are represented as bright streaking lines across the CT image (Fig. 1).

Otsu's method is automatic thresholding, that minimizes the variance within the class. The selection of suitable number of classes in thresholding is 50, which means that the image is segmented into 50 separate classes (n = 50). After implementation of Otsu's thresholding method, corrupted pixels are shown as white pixels in the obtained threshold mask (Fig. 2).

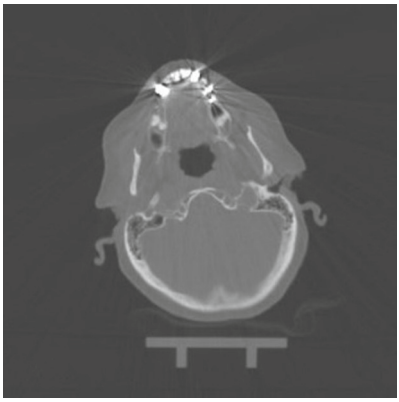

Fig. 1. Original CT image

Second step considers the usage of two dimensional 3 × 3 window (kernel) that moves across the image, pixel by pixel, positioning the window over the central pixel through the entire image. If the central pixel is corrupted, its value is changed and an output image is created from pixels that are replaced with the mean value from neighbouring pixels in the 3 × 3 kernel, based on the values under the mask. In case the central pixel is not corrupted, the central pixel's value remains unchanged and the kernel is sled to the next position.

CT images are in DICOM (Digital Imaging and Communication in Medicine) format. Matlab is capable of reading the DICOM format and stores the image in an array. Images have 512 × 512 Gy scale pixel resolution, so there is an obvious need for additional rows

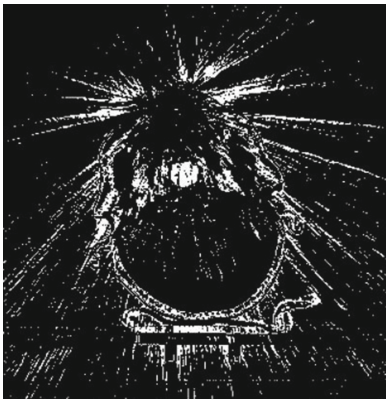

Fig. 2. Corresponding threshold mask

and columns at the edges of the image, considering limited applicability of the method to border pixels. The first two and the last two columns, as well as the first two and the last two rows are replicated at edges of the image. After addition of rows and columns CT image now has 516 × 516 Gy scale pixel resolution.

4 Results and Discussion

Metal artefacts can corrupt CT images so severely that they become major challenge for interpretation and for later diagnostic purpose. In this paper, an image-based method is proposed to reduce artefacts caused by permanent metallic implants in CT images. The performance of this method is evaluated on a real dataset, not simulated data and all algorithms for this study were developed in Matlab. The results of the proposed method are shown in Fig. 3.

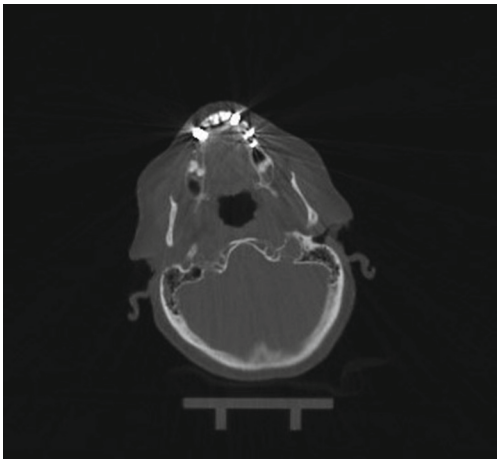

Fig. 3. CT image after the implementation of the proposed method

This paper is based on CT images with dental fillings, due to the fact that majority of patients possess dental metallic implants that cause missing projection data and streaking lines. Considering the results of study conducted on population of 100 patients, the 78% had dental fillings or implants containing some other material such as silver, while 16% of population had orthopaedic hips and 6% of sample had some metallic hardware [7]. In the future, this method can be implemented not only for dental fillings but also for wide range of CT images disturbed by artefacts that originate from artefacts other then dental fillings. Further improvement could be to use a larger number of classes in order to perform better segmentation.

The contribution to the level of artefacts in concrete image depends on the type, size, position and density of the metallic implant. The most effective way for reducing metal artefacts is to prevent them by using implants that are not metallic, e.g. titanium or removal of metal implants, but that is not a common practice in clinical conditions.

5 Conclusion

This paper aims to propose method for the reduction of streaking artefacts caused by metallic objects in X-ray Computed Tomography images. Metal artefacts can severely degrade the interpretability of CT image owing to the presence of inaccuracies in medical imaging. The objective of this research is to identify corrupted regions (pixels) in CT images and replace them with the mean value from uncorrupted neighbouring pixels.

Further research should consider implementation of a 5×5 sliding window instead of 3×3 that is presented in this approach in order to upgrade the current approach. Furthermore, enhancement of artefact detection method might be addressed in future studies due to the limitation that CT generally possess, bone structures have high atomic values as well as metallic implants and thus they can be easily mistaken and it cannot be clearly defined whether it is an artefact or just a bone.

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Improving the Energy Efficiency of Pneumatic Control Systems by Using Remotely-Controlled Pressure Regulator

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Abstract. One way to save energy in pneumatic control systems is the decreasing of operating pressure. Accordingly, it is necessary to monitor the working process continuously and, in line with the current requirement, to adjust the operating pressure to provide that the actuator works with optimum, not the maximum possible, operating pressure at all times. Fulfilling these requirements is possible with the use of special, "smart" components, which can communicate with the control system during the operation. In this paper is shown the first phase in the development and implementation of a new, "smart" component – a remotely-controlled pressure regulator, which is used for the remote change of operating pressure in pneumatic control systems, during the working process. This directly improve the energy efficiency of the system because the compressed air consumption is reduced.

Keywords: Remote change of operating pressure · Force control · Pneumatic control systems · Energy efficiency

1 Introduction

Pneumatic components are usually designed for a maximum operating pressure between 8 bar and 10 bar. The maximum operating pressure is not always optimal, so, in industrial practice, the most common operating pressure is equal to 6 bar. In some production systems, for individual operations, even pressure of 6 bar is too much. Accordingly, the optimal operating pressure is the pressure at which the actuator can accomplish the set tasks (force control), with the minimal compressed air consumption (the optimality criteria is the energy efficiency). With decreasing of operating pressure, it is possible to save energy in pneumatic control systems by reducing the compressed air consumption [1–3]. One of the most usual way for pressure reduction in pneumatic control systems is using pressure regulator in parallel with non-return valve in the supply line for the no load stroke of the actuator. The example of pneumatic control scheme using this method is shown in Fig. 1.

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 135–142, 2022.
http://doi.org/10.1007/978-3-030-97947-8_18

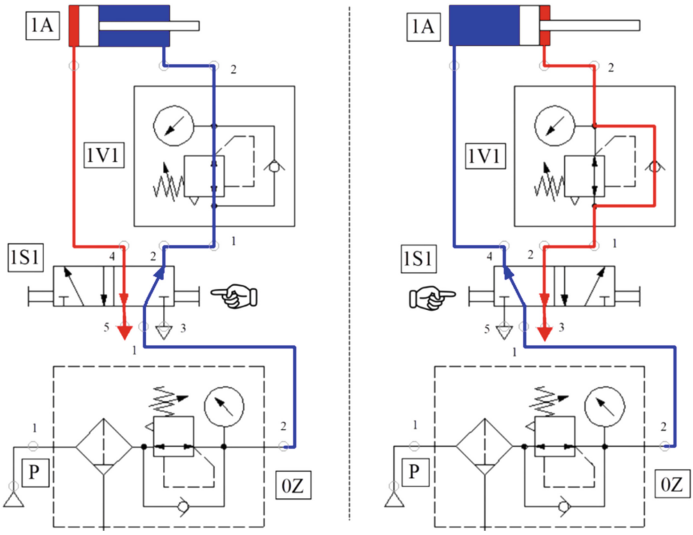

Fig. 1. The pneumatic control scheme with pressure regulator and non-return valve in parallel.

Also, the pressure regulator can be used in multi-actuator pneumatic control system, in the case when the maximum operating pressure (maximum actuator force) for individual actuator or group of actuators should not be exceeded in order to protect the workpieces, for example, from facture. Using of this method also has direct effect on the reducing of compressed air consumption and, thus, directly improve the energy efficiency of the system.

Better results could be obtained in flexible manufacturing systems, if the working process is constantly monitored, and, in line with the current requirement, the operating pressure is constantly adjusted, even from the remote location, to provide that the actuator works with optimum (for example, in case where is need to lift the lighter workpiece than the previously one, the operating pressure can be reduce), not the maximum possible, operating pressure at all times. Fulfilling these requirements is possible with the use of special, "smart" components [4], which can communicate with the control system during the working process, which is in line with the Industry 4.0 approach [5]. Thus, some pneumatic equipment manufacturers (Festo, SMC, etc.) already have developed electrically operated pressure regulators [6, 7] to allow the change of value of the operating pressure, during the working process, without direct physical contact with the component.

In this paper is shown the first phase in the development and implementation of a new, "smart" component – a remotely-controlled pressure regulator, which is used for the remote change of operating pressure in pneumatic control systems, during the working process. Compared to the commercially available, electrically controlled pressure regulators, this pressure regulator is cheaper and more suitable for simpler systems, even for systems with only one actuator and systems with low compressed air flow.

The paper is organized in a following way: Sect. 2 shows the experimental setup for the component development, as well as the mechanical construction of the component.

In Sect. 3 is presented a test application for remote control of a component as well as the obtained results. Finally, in Sect. 4, the most important conclusions are drawn and directions for further research are presented.

2 Remotely-Controlled Pressure Regulator

During the development of the remotely-controlled pressure regulator, a standard pressure regulator valve with gauge, in this case, order no. 539756, from Festo Learning system for Pneumatics, was used. It was integrated into the experimental setup shown in Fig. 2. Via a purposefully developed coupling (Fig. 2, position 2), a stepper motor (Fig. 2, position 1) was connected to pressure regulator valve (Fig. 2, position 3). The Arduino UNO microcontroller development environment (Fig. 2, position 4) and the appropriate stepper driver were used to control the operation of the stepper motor, and consequently, pressure regulator.

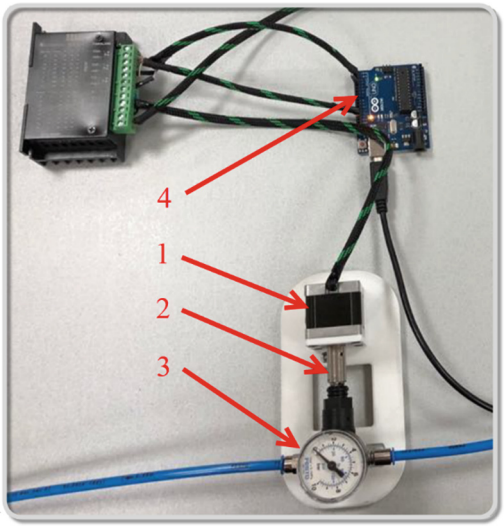

Fig. 2. Experimental setup for determination of pressure values.

It has been experimentally determined how this pressure regulator operates:

- At the beginning of measurement, the outlet pressure on pressure regulator is set to 0 bar.
- The shaft of the stepper motor was periodically rotated for a precisely defined number of steps, what led to an increase in outlet pressure.
- The current number of motor steps was recorded only for defined values of outlet pressure between 0 bar and 6 bar (including these values), in steps of 0.25 bar.
- The procedure was repeated until the outlet pressure reach the value of 6 bar.

In the next step, based on the obtained results, a graph, that show the dependence of the outlet pressure from number of motor steps, was drawn. By using polyfit function in MATLAB, is defined the inverse polynomial function that describe the dependence of the number of motor steps from the outlet pressure on pressure regulator (which is the value specified by the user). The obtained function is expressed by formula 1:

$$y = 0.5096x^7 - 10.9791x^6 + 93.0751x^5 \\ -387.9048x^4 + 790.5952x^3 - 594.9242x^2 + 594.9242x + 4620.2849 \quad (1)$$

wherein y is the number of steps of stepper motor, and x is the value of outlet pressure. To make it easier to understand, the previously explained procedure is shown in Fig. 3.

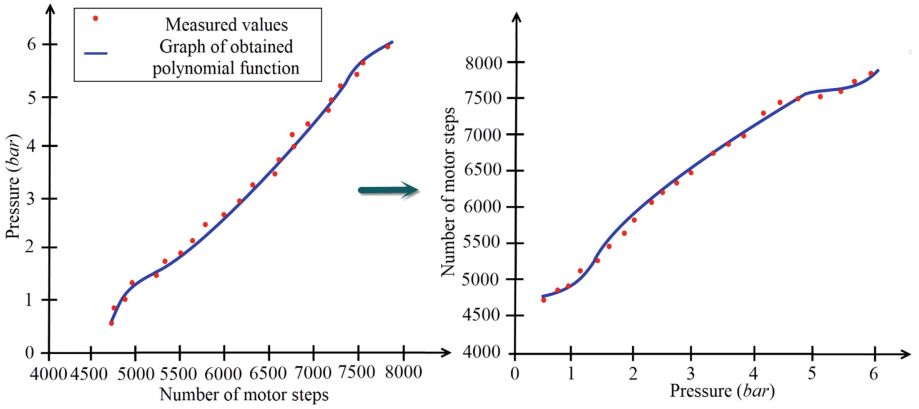

Fig. 3. The procedure of transformation of a polynomial function obtained by the measured values of outlet pressure in inverse polynomial function.

The physical realization of the prototype of the remotely-controlled pressure regulator is shown in Fig. 4.

The remotely-controlled pressure regulator consists of three main components:

- a standard pressure regulator valve with gauge, in this case, order no. 539756 [8], from Festo Learning system for Pneumatics (Fig. 4, left, position 1),
- an appropriate coupling (Fig. 4, left, position 2), and
- a stepper motor, NEMA 14 (Fig. 4, left, position 3).

The Arduino UNO microcontroller development environment (Fig. 4, left, position 4) and the appropriate stepper driver (Fig. 4, left, position 5) were used to control the operation of the stepper motor. All the above mentioned elements are integrated in the main housing (Fig. 4, left, position 6), which was made on 3D printer. Also, all necessary mounts were made on 3D printer. Several holes were made on the housing:

- for the power ports (Fig. 4, right, position 1),
- for the Arduino UNO USB port, above the power ports (Fig. 4, right, position 2), and
- for the ports of pressure regulator valve (inlet pressure – Fig. 4, left, position 7, and outlet pressure – Fig. 4, left, position 8).

The right side of the housing is partially provided in a grid, due to cooling. On the cover of housing (Fig. 4, right, position 3) is made a hole for the gauge (Fig. 4, right, position 4), so that the user can visually read the pressure value and/or track the changes of the pressure values in the system.

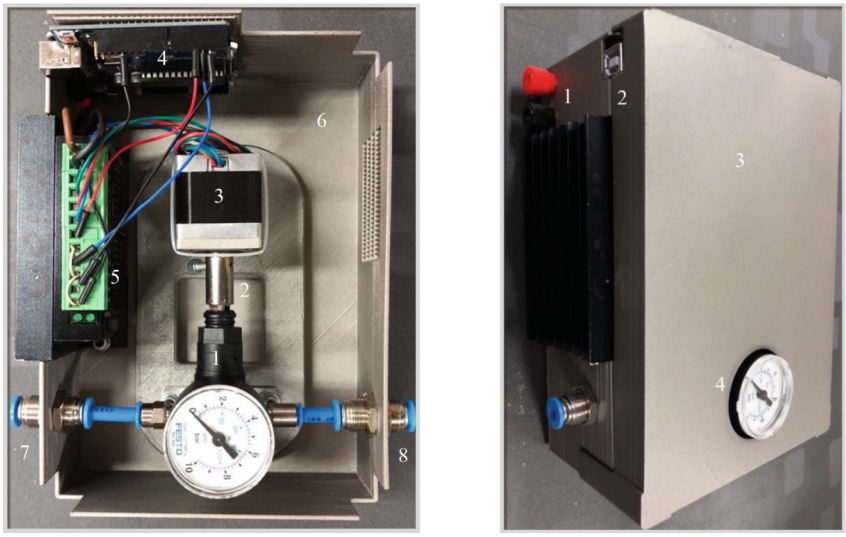

Fig. 4. The prototype of remotely-controlled pressure regulator, without cover (left), and with cover (right).

2.1 The Proposed Symbol

The development of new component requires the development of new symbol. Accordingly, for the remotely-controlled pressure regulator is proposed a new symbol, which is shown in Fig. 5.

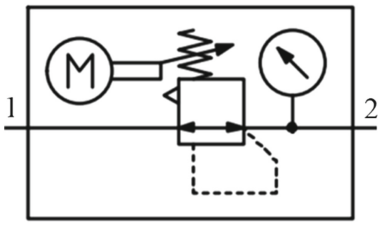

Fig. 5. The proposed symbol for remotely-controlled pressure regulator.

3 The Software Solution

For the purpose of testing of a developed prototype of remotely-controlled pressure regulator, in Java programming language is developed an application called "Remotely-controlled pressure regulator.exe" (Fig. 6). A computer, on which is installed the above mentioned user application, and the control part of remotely-controlled pressure regulator (in this case, it is the Arduino UNO microcontroller development environment) are connected by using a standard serial RS 232 communication protocol.

In the first step is necessary to enter the name of the communication port, for example "COM 1", in the field "Select communication port" (Fig. 6, position 1). The baud rate is predefined. The establishing of a connection is starting by clicking on the button named "Connect" (Fig. 6, position 2). If this procedure is successfully performed, in the field named "STATUS" will be printed a text: "The device is successfully connected." Otherwise, it will be printed a text: "Connection failed. Please try again."

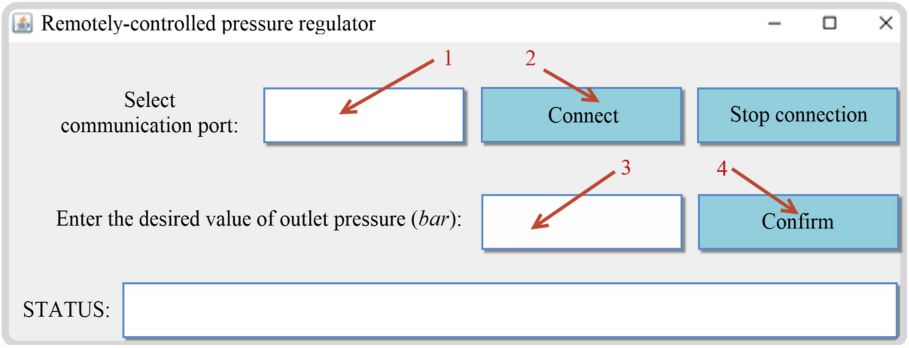

Fig. 6. User application.

After successfully connecting to the remotely-controlled pressure regulator, the user enters the desired value of outlet pressure in bar (Fig. 6, position 3), which must be in the limits from 0 bar to 6 bar. In the next step, by clicking on the button named "Confirm" (Fig. 6, position 4), the appropriate parameters are being sent to the main control device. According to a predetermined algorithm, in accordance with the formula 1, the microcontroller adjusts the position of the stepper motor, and thus adjusts the outlet pressure value on remotely-controlled pressure regulator. If the desired value of outlet pressure is outside of the permitted limits, after clicking on the button named "Confirm", in the field named "STATUS" will be printed a text: "The defined pressure is not within the permitted limits. Please, enter the new value."

3.1 Testing and Results

The accuracy and repeatability of the developed component were determined experimentally. By using pressure sensor, type MBS 3000, 060G1102, from Danfoss, the achieved values for the outlet pressure were measured. The obtained results are shown in Table 1. Roman numerals from I to V indicate the ordinal number of the test. By analyzing

the results is concluded that the maximum absolute error, which is calculated as the difference between the achieved and desired value, is −0.24 bar, at a desired operating pressure of 5.6 bar. Considering that this is a non-feedback control system, the obtained results can be rated as good. The error that occurs is due to several causes:

- creating a polynomial transfer function (formula 1) based on a smaller set values obtained by experimental testing,
- accuracy of positioning of the stepper motor, and
- errors of the measurement.

Table 1. The results of measuring the achieved value of the outlet pressure on the newly developed remotely-controlled pressure regulator.

The desired value of outlet pressure (*bar*)	The achieved value of outlet pressure (*bar*)				
	I	II	III	IV	V
1.7	1.71	1.76	1.71	1.66	1.68
2.4	2.36	2.41	2.32	2.33	2.34
3.5	3.43	3.47	3.41	3.42	3.4
4.3	4.18	4.24	4.2	4.2	4.14
5.6	5.41	5.47	5.41	5.43	5.36

4 Conclusion

In this paper is shown the first phase in the development and implementation of a remotely-controlled pressure regulator, which is used for the force control in the pneumatic control systems, during the working process. The application of this component in pneumatic control systems is in line with the Industry 4.0 approach. Namely, using of this valve has direct effect on the reducing of compressed air consumption and, thus, directly improve the energy efficiency of the system, because it allows the optimum actuator force at all times. By using this pressure regulator, the operating pressure can be changed during the working process at any time, in accordance with the current requirement.

There are several ways to improve the developed prototype of a remotely-controlled pressure regulator, before developing the final product. For example, it is possible to integrate an internal DC power supply. In addition, it is possible to implement a new way of accessing the main control device, the Arduino UNO microcontroller development environment, via Wi-Fi communication. In that way, it is possible to remove the server computer and to avoid the use of wire conductors. Additionally, there is the possibility of changing the stepper motor driver or the main control device (for example, with Arduino NANO microcontroller development environment), which would reduce the required space and thus the overall dimensions of the device, etc.

Although the obtained results were rated as good, they can be better. In order to eliminate the error of achieving the desired value of outlet pressure, it is possible to create a new transfer function (the function that describe the dependence of the number of motor steps from the outlet pressure on pressure regulator) using linear approximation. Also, it is possible to implement a feedback control.

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Optimization of the Number of Active Servers and Break Schedule: A Case Study

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Abstract. A queuing system with a single queue and a changeable number of service points is considered. The optimal break schedule for a different number of service points, as well as the optimal number of service points, are proposed. The main goal of this paper is optimizing the average waiting time, optimizing the number of service points and scheduling the break time periods. For the considered system, some basic assumptions from the classical theory of mass service are not satisfied. The complexity of the observed system is far beyond the one which is usually considered. Some standard methods used in the mass service theory (such as N-policy, T-policy, D-policy, etc.) are failing, as well as the assumptions related to the input data. Thus, simulation–based approach has to be considered. The data collected during the observation of a single postal unit are statistically analyzed and used to define parameters used in the simulation.

Keywords: Simulation optimization · Stochastic optimization · Queuing · Scheduling

1 Introduction

The aim for this research is to optimize the number of active servers and break schedule, in such a way that the utilization of servers is maximized, with acceptable waiting time. The observed queuing system in this investigation has a single line and a changeable number of service points.

Simulation modeling of a multi-server queue with Markov arrivals and priority services is considered in the paper [1]. In this queue service, there are two types of customers, customers with and without priority. In this model, service can be exponential or non-exponential. When the service has exponential distribution, this model is studied analytically, and for non-exponential service, a simulation model was used.

In the paper [2], authors developed the traffic model for multilane-multiple intersections based on the M/M/1 single server queuing system. A real case study was conducted on streets in Kuala Lumpur, and the results of the proposed model were compared with the real data. The histogram of the results was compared with the theoretical distribution, and the tests of the goodness of fit showed that the number of vehicles and the inter-arrival time had Poisson and exponential distribution, respectively. Also, two simulations

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 143–150, 2022.
http://doi.org/10.1007/978-3-030-97947-8_19

with different input parameters were conducted. The results showed good correlation between the proposed model and real data.

Another case study was conducted in the titanium dioxide refinery in Australia. Based on the collected data, statistical techniques were used to find best fitting distributions which approximate data. Using the widely spread software for simulation, the goal was to test different presumptions of the queuing systems which will lead to the improvement of productivity. Results are presented in [3].

In the paper [4], a simulation study conducted at a large airport in Western Europe, was presented. The purpose of the study was to examine the concepts of virtual queuing at the airport security line and its effect to the passengers' average waiting time as well as the costs of security.

Optimal employee scheduling for the mail delivery is the focus of the paper [5] which analyzes a linear programming model for scheduling personnel in United States postal distribution stations. Staff scheduling for mail processing and distribution centers was also studied in [6], where the model was formulated as a linear integer programing problem that includes lunch breaks for each employee.

In [7] and [8], the objective function for a Single-Server Queue that minimizes the mean waiting time, assuming a cost on server speed, is defined. In [9], the total cost is calculated as the combination of two parameters: the clerks' waiting time and the customers' waiting time.

In [10], break allocation is proposed after the optimal shift scheduling and the break windows for every shift are defined. The optimal shift scheduling with multiple break windows is studied in [11, 12] where the shift is specified by type, length, shift start time, and the number and length of breaks. The solution is obtained by integer programming and heuristics. In some papers, specified vacation policies are analyzed: group vacations (see [13–15]), temporary vacation (work on a secondary task when the queue is empty) (see [13]), or working with a lower rate (see [16, 17]).

2 Problem Description

The main aim of this research is optimization of the number of active servers and break schedule for the financial service in a postal unit in Serbia. The number of service point is changeable and appears to be independent of the number of clients in the queue because of the priority demands handled away from the service points.

In the observed postal unit, the system consists of a single queue and a changeable number of service points (1, 2 or 3). The clients are processed according to FIFO principle.

Every clerk can have a break period for 30 min during working hours and the break can start at 9:30, 10:00, 10:30 or 11:00. When an employee is on a break, the service point is idle.

The main goal is to achieve maximal utilization of the minimal number of service points, with acceptable waiting time. From the point of view of maximizing server utilization, the best solution is a single service point. The paper shows that, in the case of a single service point, the average waiting time would be greater than 25 min, which is unacceptable from the client's point of view.

The data used in this paper are obtained by recording the clients' arrival time, their waiting time (in seconds), the service duration (in seconds), the number of active servers and the number of clients. The working hours with clients were from 8 AM to 7 PM from Monday till Friday, and from 8 AM to 1 PM on Saturdays. The recording was completed in two weeks. The observed working hours were from 8 AM to 1 PM.

Based on the same data set, in the paper [18], the system of differential equations of queue size is obtained.

The statistical analyses are obtained using the distribution fitting software *EasyFit* and software package *SPSS*.

2.1 Statistical Analysis of the Recorded Data

During the observed period, the service was provided to 3885 clients. Descriptive statistics for the number of served clients, the waiting time, the inter-arrival time and the service time are provided in Table 1.

Table 1. Descriptive statistics for the number of clients, the inter-arrival time (in seconds) and the service time.

	Mean	Median	Min	Max	Variance
Number of clients	323.75	321	209	489	7090.023
Waiting time	364.16	257	0	1936	137202.46
Inter-arrival time	54.0	36	0	691	3826.597
Service time	454.03	358	6	2015	150306.614

It should be noted that is that the variance of the service time is 150306.614, i.e. the standard deviation is approximately 6.5 min and the service time can vary from 6 s to approximately 33 min. The number of clients takes the values from 209 to 489. Given the large differences in the number of customers, it is obvious that there exists a need for the changeable number of service units in time. Spearman's correlation coefficient between the queue length and the number of active servers is significant at the 0.01 level ($\rho = 0.438^{**}$). Similarly, Spearman's correlation coefficient between the waiting time and the number of active servers is significant at the 0.01 level ($\rho = 0.33^{**}$). Based on those results, it is obvious that the correlation between the queue length, and the number of active servers and the correlation between the waiting time and the number of active servers are positive and weak. The relationship between the number of active servers and the queue length and the relationship between the number of active servers and the waiting time are presented on the scatterplot in Fig. 1.

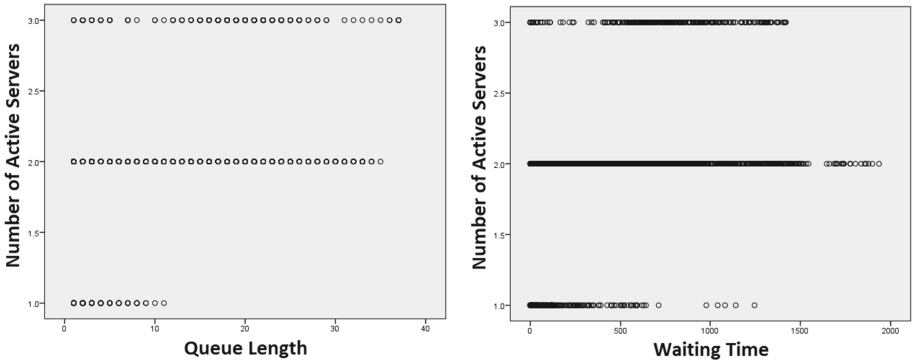

Fig. 1. Queue length and the number of active servers, and the waiting time and the number of active servers.

Based on statistical analysis of inter-arrival time performed in [18], it is shown that 7 of 12 time periods are compatible with the exponential distribution (with different parameters). Since it is less than 60% of the sample, each of the considered 12 time periods was divided into 10 sub-periods 30 min long. In this case, 94% of the sample is compatible with the exponential distribution (with different parameters).

The service time for all obtained 120 sub-periods was log-normally distributed, with different parameters.

Because of the complexity of the observed system (the service time for 120 sub-periods is estimated with log-normal distributions with different parameters and the inter-arrival time for 112 sub-periods is estimated with exponential distributions with different parameters) the simulation approach for estimating the number of active servers and break schedule is applied in this research.

3 Simulation

In order to analyze the system better, the *PostSIM* simulation software is developed (in C# programming language) to simulate a queue system with a configurable number of service points and break periods. The goal of the development of the simulation model and the use of simulation results is to optimize the choice of a number of service points in the considered postal unit.

3.1 The Optimization Criteria

The utilization factors δ_k, $k \in \{1, 2, 3\}$ of service points (expressed in percents) are calculated as

$$\delta_k = \begin{cases} 0, \hat{\delta}_k \in [\delta_{\min}, \delta_{\max}] \\ \hat{\delta}_k - \delta_{\max}, \hat{\delta}_k > \delta_{\max} \\ \delta_{\min} - \hat{\delta}_k, \hat{\delta}_k < \delta_{\min} \end{cases}, \tag{1}$$

where boundary values of service point utilization δ_{min} and δ_{max} are defined by the system management, and $\hat{\delta}_k$ is the expected value of the utilization of the service point k, $k \in \{1, 2, 3\}$.

The utilization factors of service points depend on the break schedule. All clerks have to use a break, which lasts for 30 min, in the period from 9:30 AM until 11:30 AM with the constraint that, at the specific time period, at least one service point has to be active. Consequently, four possible break time ranges were considered, as shown in Table 2.

Table 2. Break period modes.

Mode	1	2	3	4
Break period	9:30–10:00	10:00–10:30	10:30–11:00	11:00–11:30

Configuration P_x, $x \in \{1, 2, 3, 4\}$ represents the system with one service point with the break mode x. Configuration P_{xy} represents the system with two service points, where indexes $x, y \in \{1, 2, 3, 4\}$, $x \neq y$ represent break period modes for the first and for the second service point, respectively. Similarly, configuration P_{xyz}, where $x, y \in \{1, 2, 3, 4\}$, and $\neg(\mathrm{x} = \mathrm{y} = \mathrm{z})$, represents the system with three service points with a particular break mode combination.

For P_x let us consider the function

$$F_{1,x} = \frac{\overline{w}}{60} + T\delta_1, \tag{2}$$

for P_{xy} let us consider the function

$$F_{2,xy} = \frac{\overline{w}}{60} + \frac{T}{2}\sum_{I=1}^{2}\delta_i, \tag{3}$$

and for P_{xyz} let us consider the function

$$F_{3,xyz} = \frac{\overline{w}}{60} + \frac{T}{3}\sum_{I=1}^{3}\delta_i, \tag{4}$$

where the maximum queue length is limited, $\frac{\overline{w}}{60}$ is the average waiting time in minutes and T is the total simulation time.

Hence, the optimization problem can be represented as

$$F = \min\{F_1, F_2, F_3\}, \tag{5}$$

where $F_1 = \min\limits_x F_{1,x}$, $F_2 = \min\limits_x F_{2,xy}$ and $F_3 = \min\limits_x F_{3,xyz}$.

3.2 Simulation Model

The input data for the simulation model is the number of service points $n, n \in \{1, 2, 3\}$ and two vectors: inter-arrival time $R = (r_1, r_2, \ldots, r_c)$ and service time $S = (s_1, s_2, \ldots, s_c)$, where c is the total number of clients.

After each replication, some outputs are analyzed in order to realize the optimal configuration. Analyzed outputs are service point utilization Δ, average waiting time $\overline{w}$ and maximum queue length l_Q. In case of a system with one service point $\Delta = (\delta_1)$ if there are two active service points in the system $\Delta = (\delta_1, \delta_2)$ and for three active service points $\Delta = (\delta_1, \delta_2, \delta_3)$. The maximum allowed length of the queue for the simulation is 30, although this paper considers an infinite queue. Boundary values of utilization factors of service points are $\delta_{min} = 0.5$ and $\delta_{max} = 0.75$.

The system is shown in Fig. 2.

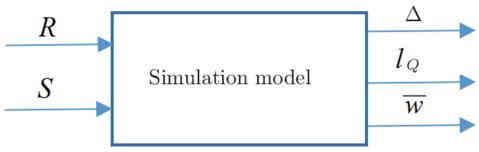

Fig. 2. Postal unit simulation diagram.

3.3 Experimental Results

Experiments were performed in two phases.

1. Optimization of break scheduling.
2. Optimization of the number of service points.

In the case of a system with one service point, the simulation showed that the service point utilization is 91.2375%, l_Q is approximately 75 clients and the average waiting time is 26.8578 min. Since the service point utilization exceeds 75% and the queue length is greater than maximum allowed queue length, this system configuration is rejected.

The results obtained for two service points are shown in Table 3.

The optimal break mode for the system with two service points is P_{14} when the first clerk uses the break from 9:30 AM until 10:00 AM and the second clerk uses the break from 11:00 AM until 11:30 AM, i.e. $F_2 = F_{2,14}$.

The results are similar for 3 service points. The optimal break mode for the system with three service points is P_{112}, when the first clerk uses the break from 9:30 AM until 10:00 AM, the second clerk uses the break from 9:30 AM until 10:00 AM and the third clerk uses the break from 10:00 AM until 10:30 AM, i.e. $F_3 = F_{3,112}$.

Since the average maximum queue length in case of one service point is greater than the maximum allowed length of the line, this model is rejected and (5) has the form $= \min\{F_2, F_3\} = F_{2,14}$.

The conclusion is that the considered postal unit will work optimally with two service points with the system configuration P_{14}.

Table 3. Simulation results for the break scheduling for the system with 2 service points.

Break mode	$\hat{\delta}_1[\%]$	$\hat{\delta}_2[\%]$	l_Q	$\overline{w}$	$F_{2,xy}$
P_{12}	52.473	50.372	29.983	355.8737	5.931228
P_{13}	52.562	50.739	29.887	319.5195	5.325324
$\boldsymbol{P_{14}}$	**52.813**	**51.014**	**24.816**	**259.2073**	**4.320122**
P_{23}	51.72	51.399	41.022	518.5312	Rejected
P_{24}	51.695	51.371	33.441	419.1754	Rejected
P_{34}	51.793	51.658	39.286	453.8721	Rejected

4 Conclusion

The main goals in this paper were optimizing the average waiting time, optimizing the number of service points and scheduling the break time periods. For the considered system, some basic assumptions from the classical theory of mass service are not satisfied. The complexity of the observed system was far beyond the one which is usually considered. Some standard methods used in the mass service theory (such as *N*-policy, *T*-policy, *D*-policy, etc.) failed, as well as the assumptions related to the input data. Thus, the simulation-based approach had to be considered.

The data collected during the observation of a single postal unit were statistically analyzed and used to define parameters which were used in the simulation. Algorithms for finding the optimal number of service points and the optimal break scheduling for a different number of service points. The output parameters, important for the system management, directly affect the employees' and customers' satisfaction and can be used by the system management to increase productivity at work.

Acknowledgment. The authors are supported by the Department of Fundamental Disciplines, Faculty of Technical Sciences, University of Novi Sad, through the project "Naučni i pedagoški rad na doktorskim studijama".

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The Validity of Adopting the Knowledge Management Strategy as a Development Policy of the University of Novi Sad

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Abstract. The paper investigates the validity and necessity for the development of the Knowledge Management Strategy at the University of Novi Sad as a management policy towards the development and the implementation of development trends. The research is based on the needs analysis of all 14 faculties of the University of Novi Sad for knowledge management strategies according to which these educational organizations would be guided. Knowledge management as a development process promotes modern forms of e-learning, and supports strategic planning, decision-making and problem solving. The development of educational technologies has introduced changes in learning models at faculties and universities around the world. The basic elements that are analyzed in this paper considering the Knowledge Management Strategy at the University of Novi Sad are resources - hardware and software, practices and methods, and internal and external factors. The universality of this topic opens up new vistas for every faculty and university which is considering the introduction and adoption of the Knowledge Management Strategy. In addition, the Knowledge Management Strategy at the University of Novi Sad points to the possibilities of strategic alliances that bring a huge potential for acquiring new knowledge as well as international cooperation based on knowledge management.

Keywords: Knowledge management strategies · General knowledge management strategies · Generic knowledge management strategies · University of Novi Sad · Strategic alliances · International cooperation

1 Knowledge Management in the Function of the Development of the University of Novi Sad (Hereinafter Referred to as UNS)

Knowledge Management (hereinafter referred to as KM) is the ability of harnessing knowledge, involving staff, organization culture, processes and technology. As such a whole, KM has, in recent decades, led to the development of numerous organisations that offer services, mostly IT services and education. Value appraisal of such organisations exceeds the traditional accountancy, so various appraisal models have been introduced in an attempt to measure the immaterial values of the organisations acquired by KM.

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 151–158, 2022.
http://doi.org/10.1007/978-3-030-97947-8_20

The increased worldwide interest in intangible assets occurred along with the awareness that financial accounting reports do not reflect an organisation in such a way to generate new value. Increasing differences between market and accounting values of organisations based on knowledge have constantly been observed and they have especially been dominant in the fields that base their primary activities in the IT sector. Empirical measurability through attempts to reflect intangible assets in financial reports is constantly developing resulting in registration of a considerable number of methods for measuring intangible tools, although most of them remain unused. Models of measurement systems of intangible assets are constantly developing in search of a widely accepted method of organisational value resulting from KM. "If you cannot measure it, you cannot manage it. The organisation's measurement system strongly affects the behaviour of people both inside and outside the organisation" [1]. If companies are to survive and prosper in information age competition, they must use measurement and management systems. Intangible assets like knowledge combined with technological development are crucial for the level of productivity, and thus for generating development strategies. If an organisation is considered to be a set of activities, it is at the same time a set of technologies involved in almost every organisation activity, and, due to the reversible influence of technological change, it affects every activity. This implies that technological changes affect the organisational development and organisational culture. The permeation of Information Systems Technology in the value chain of each activity leads to creating value, which simultaneously generates, but also uses, information. In order to form the development strategy base based on knowledge, it is necessary to provide answers to three strategic questions – Where are we? Where do we want to be? How do we get there? The addition to the KM Strategy is the information and communication strategy, predominantly referring to IT offer and its application in development, which, along with internationalisation and other strategies that are brought to UNS, represent the core strategy set which is at the same time the support to strategic planning, decision making and problem solving. Bearing in mind the fact that the results of KM Strategy application cannot be expressed by quantitative indicators either, they are expressed in the category of intangible tools. Consequently, it is impossible to express by quantitative indicators the rate of return of investment (ROI) as an indicator of success of KM Strategy application at UNS. Of course, the necessity and validity of KM Strategy implementation at UNS is simultaneously investigated because, apart from adequate hardware and software, successful KM requires effective management of processes and people as well as an applicative KM Strategy. The jurisdiction to create the KM Strategy, apart from authorised governmental institutions at UNS, belongs to the UNS Council and the Strategic Development Committee at UNS which are to provide clear guidelines to formulate the KM Strategy at UNS. In order to implement the KM Strategy, it is of utmost importance to employ a knowledge worker to manage all the project activities in order to establish, develop and implement the KM concept. The success of KM programme at UNS is predominantly determined by the above-mentioned institutional bodies and their endorsement of the proposal for drafting an adopting the KM Strategy. They are to coordinate it with other strategies and acts, draw up the budget, name the knowledge manager and participate in the process itself. During the Strategy introduction into a learning organisation, that is into UNS, it is important to identify new

functions related to the knowledge concept which leads to the institutionalisation of new roles among which the primary are Chief Knowledge Officer (CKO) who is in charge of the following activities: determination of strategic priorities in KM, knowledge base forming and monitoring; cooperation with organisational managers in order to establish organisational learning environment; launch of intellectual capital management process; control by obtaining feedback [2] and Chief Learning Officer (CLO) manages the team that executes, in other words, implements and monitors organisational learning [3]. In order to carry out their tasks, knowledge managers require clear descriptions of their work activities determined by the authority system which in its counselling and monitoring capacity participates in designing and implementation of a KM model. The KM Strategy contributes to the modernisation of teaching processes and cultural change at UNS, as well as generating new values and reduction of expenses. Resources analysed in order to reach the conclusion on the necessity of drawing up the KM Strategy at UNS include hardware and software, practices and methods, and internal and external factors researched through the following research chapters: organisational culture, organisational processes, management, leadership and technology.

Organisational structure adjustment process requires certain preparation phases that will lead the organisation into upcoming changes in order to overcome possible obstructions caused by existing formal and informal structures at UNS.

The 'EU 2020' strategy programme enlists the same factors that reflect the perspective of the UNS development [4] among its key initiating development factors:

1. Generating value from growth based on knowledge, which implies product and process innovation development, as well as the use of education, research and digital economy potential;
2. Enabling staff by acquiring new skills, support of creativity and innovation, development of entrepreneurship and flexibility to job change;

Development as a social category represents a constant process of increasing the ability to satisfy aggregate society needs concerning financial power, standard of living, social well-being, political freedom and social satisfaction. The development of UNS based on KM includes comprehensive planning of organisational change in order to enhance business activities and achieve positive results in its work. The research explored the potential and resources of each Faculty of UNS for the implementation of key methods of KM in e-teaching and other kinds of communication. The development of UNS based on KM according to the research is based on its organisational culture, human resources and leadership of individuals within the organisation in the field of knowledge management. Knowledge Management at UNS requires voluntary participation of teaching, administrative and technical staff in order to obtain benefit for higher education institutions. The development of UNS based on KM is related to skills and training of all the employees, relationship network and IT infrastructure. By analysing the development potential of UNS based on KM and by designing applicable strategies, it has been concluded that it is possible to steer the development of higher education, that is UNS, in that way. Strategic KM at UNS is one of the necessary preconditions to enhance the quality of work, growth and development. Quality long-term strategic positioning of UNS is impossible to achieve if KM based development is excluded.

Apart from intraorganisational KM, for a bigger picture of development it is necessary to include the reversible cooperation between the UNS and economy, research, protection of intellectual assets and private scientific institutions development. Knowledge management contributes to the development of the necessary individual competencies and the successful implementation of R&D strategy, yielding increased organizational performance [5].

2 Knowledge Management Strategies

Strategies of KM in the function of UNS development imply planned and designed KM, and it is paramount that they are compatible with other UNS strategies, including its comprehensive long-term development. The KM concept implies designing knowledge based products and services. Apart from a general KM Strategy that refers to primary activities of the learning organisation, there are also generic KM strategies that refer to knowledge modifications and transformations from one form to another.

Generic KM strategies are based on the basic and most important division of knowledge into explicit and implicit. Explicit knowledge is the knowledge that can be expressed in formal language and can be exchanged among individuals, whereas implicit knowledge is personal knowledge related to personal experience and it encompasses intangible factors such as personal beliefs, values and perspective [6].

KM Strategy is administratively and formally important a part of strategic planning as it participates more actively in social relations, political development guidelines and in the international system of higher education institutions in order to raise the level of merchantability.

Emphasising the need to form the KM Strategy at UNS is based on evident needs for more efficient KM recognised in the research carried out in the period from 13th January to 10th February, 2020 by means of an online survey. The surveyees included representatives of teaching, technical and administrative staff of all fourteen Faculties of UNS. Another indicator for the obvious need for the development Strategy based on KM reflects the need for continued adjustment to changes related to hardware and software development in educational technologies, in other words, the readiness of higher education institutions to adjust to their changes. Universities as institutions that generate and convey knowledge are the key factor of growth and development of both national and global economics. According to research results stated below, one can notice that uncertainty is the predominant attitude when basics of KM concept are in question.

Out of 284 surveyees including teaching, administrative and technical staff of UNS, 76% replied that they do not know if the Faculty possesses the official KM programme or strategy. When it comes to the awareness of the KM concept, the remaining surveyees showed a high percentage of uncertainty which is represented with the following results.

To the question "I am fully acquainted with the concept of KM", out of 282 responses, most surveyees replied with 'I am not sure' 32.98%, 'I mostly agree' 20.92%, 'I mostly disagree' 19.15%, 'I completely disagree' 18.09%, 'I completely agree' 8.87% and weighted average 2.83%.

To the question "KM Programme at the Faculty is fully applied and functions well", out of 278 responses, most surveyees replied with 'I am not sure' 62.23%, 'I completely

disagree' 16.19%, with 'I mostly agree' 9.71%, 'I mostly disagree' 8.99%, 'I completely agree' 2.88% and weighted average 2.73%.

To the question "The existing KM Programme at the Faculty makes my work much easier", out of 279 responses, most surveyees replied with 'I am not sure' 55.20%, 'I completely disagree' 20.43%, 'I mostly disagree' 10.75%, 'I mostly agree' 8.96%, 'I completely agree' 4.66%, and weighed average 2.67%.

The results stated above confirm the assumption which led to this research in the first place – that the awareness of KM, in accordance with modern education technologies, is not defined by an appropriate legal act (programme or strategy) and therefore generates uncertainty in highly educated workers which impedes developmental self-sustained processes. Thus, it is concluded that, in order to enhance the KM and education technology based development at UNS, it is necessary to pass an appropriate legal act that would create a mutual vision for the teaching, administrative and technical staff and lead them towards a mutual strategic goal. KM, regarded as a developmental process of the Faculties of UNS, is related to modern distance learning achievements, simultaneously supporting strategic planning, decision making and problem solving by making the KM model applicable for technical and administrative staff.

2.1 General Knowledge Management Strategies

Day and Wendler from McKinsey & Company, an American management consulting firm identified five fundamental KM strategies [5].

Strategy of development and best practice transfer within the concept of KM implies that after identifying the best practice in an organisation, it should be dispersed via the dispersed web of locations.

Strategy of creating new industries from the existing knowledge is related to the recognition of organisational knowledge that can be used in a new way which, until then, has not been used in the organisation.

Strategy of shaping corporate strategy for knowledge includes a re-evaluation of current environment factors, and based on strategic options, form a corporate strategy based on the existing organisational knowledge. This strategy aids the recognition of needs for necessary knowledge, which leads to permanent upgrade of organisation knowledge, in accordance with strategic goals. The newly acquired organisational knowledge by creating new organisational possibilities may create the need to reformulate the corporate strategy.

Strategy of generation and commercialisation of innovations based on the increased number of technological innovations in the function of KM at UNS. Education technologies are in focus for the purpose of this strategy.

Strategy of creating standards by releasing own knowledge is widely used in software industry and it is related to publicly available organisational knowledge, which affects the growth of the number of users, providing numerous benefits to such an organisation. While general strategies are more applicable to large organisations, generic strategies are more practical for small organisations.

2.2 Generic Knowledge Management Strategies

Knowledge is transferred by interaction between implicit and explicit knowledge by means of the four generic KM strategies stated below:

1. Socialization is a process of 'hidden' knowledge transfer among individuals before it becomes explicit. It is best explained by the model of learning taking place by verbal learning and imitation. Socialization as a process transfers not only knowledge and skills, but also ways of working, norms and values. As a strategy, socialization mostly requires direct contact, although there are knowledge transfer modes by means of two-way audio-visual communication.
2. Externalization is a process of transformation of 'tacit' knowledge into explicit. It is about codification of implicit knowledge into some form of permanent media that has a standard physical form. That way, the organisation is protected from losing the accumulated implicit knowledge from the previous period [8]. This strategy yields results in much shorter time and decreases expenditures at the same time.
3. Combination is a process of converting one explicit state into another. Various concepts are combined in order to create new, bigger units of knowledge. This strategy represents the upgrade of the existing explicit knowledge.
4. Internalization is a process in which explicit knowledge is converted into 'tacit' knowledge. It is usually about applying knowledge into practice [9].

The stated strategies can be applied individually, however, their combined use in practice is frequent and it yields maximum KM results.

Human capital survey encompasses the motivation of employees to adopt the KM concept in their work thus contributing to the development of organisational culture. For the purpose of this research, organisational culture is defined as a system of mutual trust, understanding, norms of behaviour and value which greatly determine behaviour, thinking and actions of employees of an organisation, and KM as a collaborative and integrated approach to knowledge within an organisation where everyone in that organisation is provided with an easy and quick access to all the necessary knowledge and information by means of modern information technologies.

Motivation is affected by a variety of mutually conditioned factors:

1. Personal characteristics of an individual (attitudes, needs, interests, aspirations, abilities, personal features, internal motivation, achievement motives);
2. Job characteristics (the job type, degree of self-control, responsibility, autonomy, complexity of work, creativity);
3. Characteristics of a wider work environment and overall climate in the organisation – organisational ambient (management, organisation, communication, interpersonal relationships);
4. Degrees and characteristics of technological and economic growth of the organisation and society as a whole;
5. Socioeconomic relations and system of values, cultures, religion, geographic region [10].

In order for the organisational culture to completely support and motivate the knowledge worker, he or she should be offered the following opportunities:

1. Personal development – the chance for an individual to fulfil his/her full potential;
2. Operational autonomy – work environment which enables the knowledge workers to fulfil the tasks they were given within the scope of the strategic trend and in accordance with self-evaluation indicators;
3. Task fulfilment – the opportunity to get the job done at the level and according to standards and quality an individual can be proud of;
4. Money – earning an income which rewards the contribution and enables the employees to share the abundance they created together [11].

2.3 Strategic Alliances and International Cooperation

Perspectives of future development based on research – In the long run, in order for the University to make strategic progress, a core strategy set is crucial, where the KM Strategy is compatible with other general university strategies such as Partnership Strategy; Teaching and Learning Strategy; Information and Communication Strategy, Internationalisation Strategy etc. Among the publicly accessible acts, UNS currently possesses the Internationalisation Strategy. International organisations that deal with KM, education technologies and education policies provide with their organisational activities the enhancement of teaching processes in higher education by means of various educational programmes. According to their own decisions, higher education institutions can be members of international non-governmental educational organisations and alliances that keep pace with the development of education technologies, knowledge management and education policies by offering adequate trainings for their use and other forms of education by means of publications, seminars, webinars, collaborative projects and other forms of cooperation.

3 Conclusion

Strategic KM connects the teaching activities at UNS and the KM concept into a whole that affects the self-sustainable development, competitiveness, and thus reinforces institutional stability and UNS survival. Apart from the above-stated, the validity and necessity of designing the KM Strategy at UNS in the function of the development is also recognised in the ability to, by means of KM concept, establish stronger connections with the economic and political system and thus achieve efficiency and effectiveness in institutional relations. Apart from the theoretical confirmation and according to the part of survey presented in this paper, a real need for the KM Strategy adoption is identified. By comparing tangible and intangible assets relevant to the KM concept available to the Faculties of UNS, it is concluded that the formulation, adoption and application of the KM Strategy would considerably contribute to the development of UNS. KM and continuous investment into knowledge and technology that supports the KM concept is a way of creating value, that is, generation higher added value to products and generated knowledge and its transfer as created services. Internationalisation of new positions of KM at

UNS enables efficient KM adoption an implementation of KM Strategy. This research is assuming a universal character as it can be fully or partially adopted in the course of support of the development of higher education institutions based on KM worldwide. In relation to that, it is recommended that the higher education scientific institutions explore the following factors and relations within their organizations in order to obtain a precisely profiled KM strategy: human resources, available potentials and calculations necessary for adoption of new forms of distant learning primarily for the purpose of staff training and adequate IT infrastructure which enables, in terms of hardware and software, modern interactive forms of distance learning.

Acknowledgments. This paper is part of research within the scope of the project "Knowledge Management – University of Novi Sad Development Policy in 2020". The funds for this project were provided by the Autonomous Province of Vojvodina, Provincial Secretariat for Higher Education and Scientific Research.

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Project Management Challenges in Implementing Agile Methods in Manufacturing SMEs

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Abstract. A changing business environment brings unpredictable and uncertain future for companies. While demands and expectations of stakeholders are simultaneously growing, on the other hand, companies need to be agile - to design their processes in the way to respond effectively to current and upcoming changes. Although agile project management has been primarily related to the software development, it can be applied to other processes, such as manufacturing. Manufacturing business processes are ones that are the most complex and require using appropriate methodology, tools and techniques to achieve specific process objectives. Due to a lack of resources, SMEs (Small and Medium Enterprises) not likely to make use of formalized project management practices, but some of their elements are used in order to achieve a higher efficiency of the production process. The purpose of this paper is to examine to what extent traditional and agile project management methods can improve success of business activities in manufacturing SMEs. Based on the previous researches, authors have a tendency to show a strong relation between using project management practices and improving business performances in SMEs.

Keywords: Project management · Agility · SMEs · Business performance

1 Introduction

Why is project management important for SMEs? Project management has been developed from the industry with the aim to ensure a higher level of success of business activities. In the first time, it had been used for larger companies effectively, smaller companies had not been suitable to implement formal project management approaches due to their limitations. In the last decade SMEs, especially manufacturing ones, recognize the need for using project management in its less formal structure [1].

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 159–164, 2022.
http://doi.org/10.1007/978-3-030-97947-8_21

Ghobadian and Gallear (1997) defined main differences between SMEs and larger organizations [2], especially in the term of simpler planning and control in SMEs, a lower degree of standardization and decision making specialization high degree of innovativeness.

The overall research question in this paper is to what extent traditional and agile project management methods can improve the success of business activities in manufacturing SMEs? Following this question, the level of using agile project management practices in manufacturing SMEs can be considered as important for helping SMEs to be more effective and to achieve successful results.

Author Youssef [3] defined agility not only as a fast response but as an approach that requires structural and infrastructural changes in the company and its internal and external environment.

The agile approach is mostly depending on the competence of people and quality of the information. Author Gunasekaran (1999) emphasized term of flexibility as a basis for agility, which can be achieved through the integration of the people, information and technology [4]. Thus, agile project management is recognized as a useful method for continuous improvement and iteration at every stage of the company's activities.

Despite the advantages of the agile approach, many companies still use more traditional strategies of project management or combined these two approaches.

2 Project Management Approach in SMEs

Project management as a formalized approach has been used since 60 from last century. Timely, it has been upgraded, extended and improved in many of its elements.

The most famous world institution for project management is the Project Management Institute (PMI) in the United States. The PMI guideline defines project management areas and processes that are applicable in each organization regardless its size, type of industry sector, level of technology utilization, etc. [5] However, many authors agreed that formal project management methodologies are not appropriate for smaller companies because of their built-in limitations.

All knowledge areas take a significant place in the process of project management implementation, need to be harmonized and spatial and temporal synchronized. For this purpose, many authors have suggested using a project management approach or some of its elements in SMEs to establish a more effective and more flexible organization. [6–9].

SMEs are facing multifarious problems relating to their size and structure, thus the adaptation of project management strategies and methods for SMEs need to be harmonized with those requirements [10].

Using project management approach within SME brings many advantages. According to the research done by authors, Turner and Ledwith respondents highlighted several benefits of implementing Project management, some of them are s following (with the average score in the survey more than 4) [1]:

– Results of projects are more predictable;
– Better control of projects;
– Clients are more satisfied at the end of the project;
– Company is more likely to achieve the triple constraint;
– The project deliverable performs as required;
– Responsibility and accountability within the team is clear;
– Top management is better informed.

The listed benefits include both internal and external factors, and focus is on achieving customer's requirements.

The main challenges for implementing project management in SMEs are directly related to their built-in limitations such as insufficient financial resources, lack of education in the field of project management, bureaucracy, etc. [1].

3 Traditional vs. Agile Project Management Strategies

In the literature, it can be found several classifications of project management strategies [12, 13] and for the purpose of this paper; it will be presented five strategies – two traditional and three agile [14]. Authors emphasized the main advantages and challenges for each strategy (summarized in Table 1).

Furthermore, with the aim of better understanding these strategies, authors Fernandez, D. J., & Fernandez, J. D. (2008) [14] presented Quadrant with two dimensions – Clarity of goal and clarity of solutions is presented.

Taking into account these two dimensions the four strategies can be defined.

Linear - traditional strategy where the project solution is not released until the end. *Incremental*-similar to traditional expects that a partial solution is released after each phase of the project.

Iterative- number of repeated phases with feedback after each completed group of phases.

Adaptive- similar to an Iterative strategy except that with each iteration's feedback adjusts the next iteration.

Extreme- similar to an Adaptive strategy but the goal of the project must be discovered and clearly defined [14].

Each of the described strategies has its own strengths and challenges when it comes to its implementation within business operations. In Table 1 there are presented the most important strengths for each strategy.

Table 1. The main strengths of traditional and agile project management strategies [13, 14]

Strategy	Main strengths
Linear	L1 All project activities are scheduled; L2 Resource requirements are known for all team members; L3 Team members can be easily moved to another position; L4 Following a defined set of processes; L5 Plan and schedule are not suitable to changes; L6 Competition time can be longer;
Incremental	IN1 Business value is produced earlier in the project life cycle; IN2 Change requests can be accommodated between increments and discovered through incremental solutions; IN3 Stronger focus on customer value than the linear strategy; IN4 More customer involvement is required compared to the linear strategy;
Iterative	IT1 Customer can review current solution for suggested improvements; IT2 Scope change can be accommodated between iterations; IT3 Adapts to changing business conditions; IT4 The final solution cannot be specified to the customer at the outset of the project;
Adaptive	A1 Does not waste time on non-value-added work; A2 Provides maximum business value within the given time and cost constraints; A3 Cannot identify exactly what will be delivered at the end of the project;
Extreme	E1 Allows for keeping options open as late as possible; E2 Offers an early look at a number of partial solutions; E3 No guarantees that any business value will result from the project

To find how some specific strategies have an impact on SMEs activities and operations and to map which strategy is the most suitable for effective project management approach, authors had analyzed relations between main characteristics of SMEs and project management strategies.

Authors [6] defined the main characteristics of SMEs – lack of expertise, limited resources, local management, short-term strategy, lack of methods and procedures, non-functional organization. These characteristics are at the same time constraints for doing regular business operations and can have a significant influence on other areas, such as project management.

The traditional approach that includes linear and incremental strategies is estimated as a suitable approach for solving SME's built-in limitations. Implementation of linear strategy means that all activities are scheduled and resources requirements are known for all team members. Thus, high-level planning and detailed scheduling provide detailed insights into project tasks and activities, team members are familiar with those procedures and methods.

Adopting the traditional approach is more suitable for systems like SMEs because of their built-in limitations, but they need to be more proactive and act in line with trends

within the industry. Some significant problems, such as limited resources and short-term-strategy [6] could be successfully treated or eliminated by adopting some of agile project management strategies or by the combination of traditional and agile strategies.

4 Discussion and Conclusion

The literature review showed that both traditional and agile project management approaches are very important to SMEs. Combining the foundations of the traditional approach with modern agile methods, tools and techniques help organizations to adjust organization structure and the culture to achieve the most efficient business processes.

Smaller companies are in most cases incompatible with formal business strategies and methodologies due to their limitations. By taking certain adjustments in the existing methods, strategies, tools and models SMEs can become more flexible and more cost-efficient.

In the paper, the author made correlations between project management strategies and the main characteristics of SMEs to suggest which strategy is a best-fit solution for removing or mitigating their built-in limitations.

The traditional strategies are more suitable for SMEs but implementing agile project management strategies can help SMEs to find their place in the global business ecosystem that will make them more effective and sustainable for a long time. Creating a flexible environment allows the continuous development of SMEs that are following strict market requirements.

Some further research should include results which will give empirical evidence on project management practices in manufacturing SMEs.

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IoT-Based Delivery System in State of Emergency

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Abstract. States of emergency that occur as a consequence of epidemic and pandemic spread of the disease (influenza, Covid-19) negatively affect all human activities. In states of emergency, various measures can be applied in order to reduce the potential risks to human health and life to a minimum. The most common measures refer to the interdiction on the work of markets, the interdiction on the restriction of movement, the restriction of the number of people who can enter shops and pharmacies at the same time. These measures affect one of the most critical activities, the procurement of food products and medicines. Due to various restrictions, it is difficult or impossible for people to procure food products and medicines, especially for the elderly and the sick ones. On the other hand, this affects both producers and sellers of food products for whom the sale of food products is the main source of finance. In this paper, the conceptual solution of the IoT - based delivery system in state of emergency is presented. The proposed solution enables the connection of food producers, suppliers and customers. Customers are enabled to purchase food products and medicines more easily, while producers are enabled to place food products on the market more easily during emergencies. The proposed solution provides higher security, because contact between people is kept to a minimum and allows monitoring of the establishment of contacts in the event of the spread of infection in order to inform potential patients.

Keywords: State of emergency · Delivery · IoT

1 Introduction

Under normal circumstances, people perform various activities on a daily basis. They are going to work, going to buy food and other products that allow them to live life normally. States of emergency that can occur as a result of a natural disaster (storms, blizzards, etc.) or as a consequence of the outbreak of an epidemic or pandemic situation, make it difficult or impossible for people to perform activities necessary for the normal life. Recently, we have witnessed the pandemic spread of the disease COVID-19, which has caused a problem in all countries over the world. In order to minimize the risk to human health and lives, most countries have introduced a state of emergency. Measures have been taken to reduce people-to-people contacts in order to minimize the transmission

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 165–169, 2022.
http://doi.org/10.1007/978-3-030-97947-8_22

of the infection [1]. The most common measures referred to the ban on the operation of open-air markets and shops, restriction of movement (curfew), restriction of the number of people who can enter an enclosed space at the same time (shops and pharmacies). These measures affected one of the most important activities, the procurement of food products and medications. Due to various restrictions, it is difficult or impossible for people to procure food products and medications, especially for the elderly and the sick ones [2] or in isolation due to potential infection. On the other hand, it affects both producers and sellers of food products and medications for which the sale of food products, medications and medical preparations is the main source of funding [3–5]. Large retail chains and large food producers that have developed online product sales systems and their own food delivery systems have easily adapted to the changes that have occurred with the introduction state of emergencies. Large transportation service systems for transporting people such as Uber and carGO have introduced, in addition to the standard service of transporting people and transport of goods, most often food products that they take from producers, shops and prepared meals in restaurants and deliver them to end users [6–9]. In this way, large market participants have coped and adapted to the changes. The problem is small producers and traders of food products, small family restaurants, pharmacists and independent suppliers who cannot quickly and easily adapt to such changes in a short time.

This paper presents the solution of the delivery system in emergency situations based on IoT in the state of emergency. The proposed solution enables the connection of food producers, suppliers and food buyers, as well as other products necessary for people in emergency situations such as medications. This solution makes it easier, on one hand, for customers to buy food products and medications, while it makes it easier, on the other hand, for producers to place food products on the market in state of emergencies. Deliverers within the system represent a link between producers/sellers and customers. The proposed solution provides greater security, since contact between people is minimized and allows monitoring of the establishment of contacts in the event of the spread of infection in order to inform potential patients as well as to detect local foci of infection.

2 IoT-Based Delivery System Solution

Internet of Things (IoT) enables networking of field devices and transforms manufacturing and service operations to efficient activities [10, 11]. Some solutions suggested using of 2D barcode in different process [12]. The conceptual design of the delivery system in emergency situations is based on the interconnection of users with implementation of IoT technology. The proposed system solution consists of a server application as well as mobile and PC applications. The scheme of the IoT-based emergency delivery system based on IoT is shown in Fig. 1. The server application is used for user registration as well as for storing system user data. Users of the system represent producers of food products (farmers and restaurants), sellers of food products, deliverers as well as end users or buyers of food products and medications/medical preparations. Mobile application and PC application allow users to access system data and services. The server application enables producers and sellers of food products and medications/medical preparations to offer their products in the form of simple offers or advertisements through the system to end users. If producers and sellers have their own systems for online sales, the

server application has interfaces that allow downloading order data from these systems to organize delivery. When the end user or customer orders food products or medications/medical preparations, through a server application or through an existing online sales system with a producers and sellers, a delivery request is created to the system.

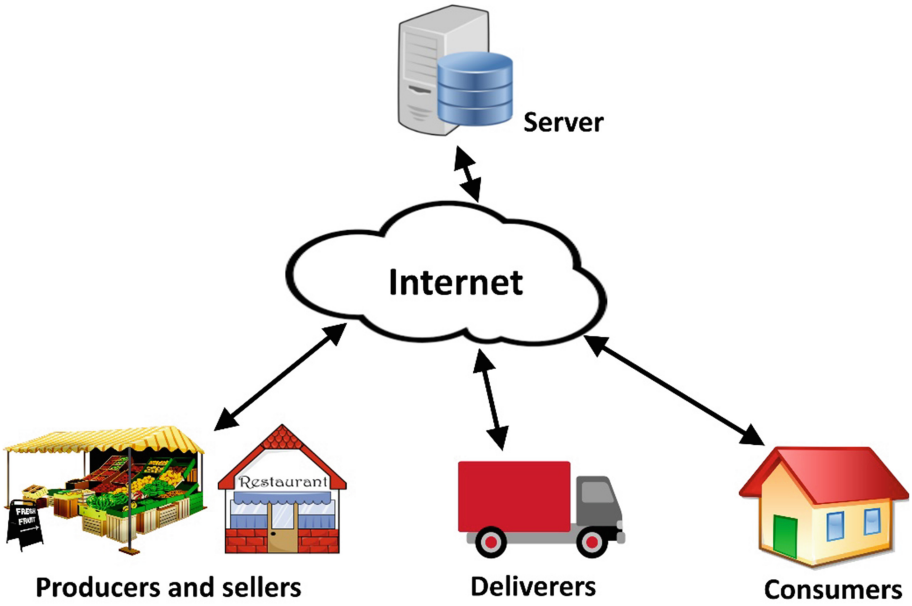

Fig. 1. The scheme of the IoT-based emergency delivery system based on IoT

The delivery request is forwarded either to all available deliverers or the producers and sellers so they can then forward the delivery request to the deliverers with whom they most often cooperate and with whom they have contract. For each package to be delivered, the deliverers have information about the location from which the package is taken and to which location it needs to be delivered. The end user has an insight into the status of package delivery and the expected delivery time. During the delivery of the package, the movement of the deliverer and the establishment of potential contacts are monitored. In case of confirmation of the infection for one of the users of the system, potential contacts can be tracked and to them can be send alert, since they can be potentially infected users.

3 Experimental System

For the purpose of proving concept, experimental system was created. In order to accelerate the implementation of the experimental system, as a basis for the implementation of the delivery system in emergency situations, a system for the delivery of food products by cargo bicycles based on IoT was used [13]. Functionalities of the existing system were used, such as displaying the list of delivery requests, displaying the delivery provider to

the location of package pick-up as well as to the location of package delivery, and user notifications in case of creating delivery requests and changes in the delivery list. When the end customer orders food or medications/medical preparations, a delivery request is generated in the system that is displayed to all system users like deliverer or the producer/seller and a delivery request is assigned to the preferred deliverer that they trust the most. System users receive a notification that a delivery request has been created. The deliverer have the possibility of insight into the delivery request sheet (Fig. 2a), and by selecting the request for delivery, the data on the locations of pick-up and delivery of the package are displayed, as well as the other information related to these locations (Fig. 2b and Fig. 2c) [13].

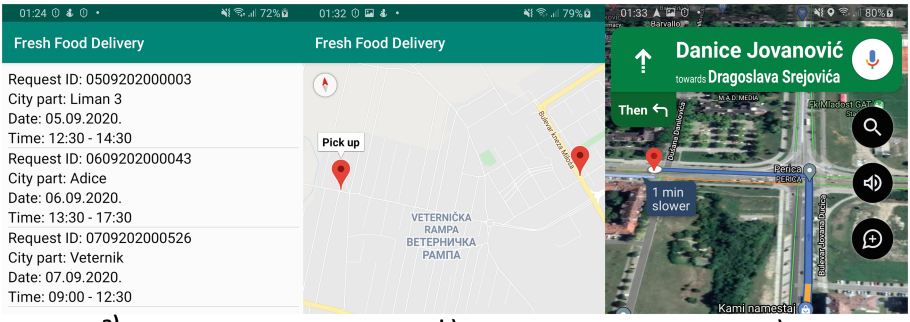

Fig. 2. Print screens of the cargo bicycle delivery application

The existing cargo bicycle delivery system has been modified so that the database has been expanded in the server application. In this way it is possible to store information on the movement of deliverers. Delivery information is collected using an extension of a dedicated Android application that implements the continuous sending of GPS (Global Positioning System) delivery positions that are collected using GPS receivers on mobile phones. Based on the processing of the collected data on the movements of the deliverer, potential contacts between people can be monitored. By combining the data on the movement of the supplier with the data on the packages to be delivered (who is the producer/seller, who is the deliverer, who is the buyer) in case of an outbreak can send potential contacts and alert users, by sending notifications or SMS (Short Message Service) or email messages to potentially infected users with instructions and advice on further procedures, in order to minimize the risk to human health and life.

4 Conclusion

In this paper, a solution of the delivery system in state of emergency based on IoT is proposed. The developed solution allows small producers, sellers and deliverers to easily adapt to the changes that arise in state of emergency. From the economic aspect, developed system enables users to continue with their business activities during state of emergency, thus leaving protected jobs and worker's earnings. From security aspect, it is

possible to monitor potential contacts during the confirmation of the infection of certain users, based on the collected data, and all potentially infected users can be informed which measures they should take in order to minimize the health risk.

Further research on this topic will be focused on the selection of optimal algorithms of data processing to monitor potential contacts of infected system users. Special attention will be towards the protection of user data due to legal regulations.

Acknowledgement. This research has been supported by the Provincial Secretariat for Higher Education and Scientific Research of Autonomous Province of Vojvodina, Republic of Serbia, through the project: "Implementation of IoT tracking system for fresh food produces from Vojvodina", and the Ministry of Education, Science and Technological Development, Government of the Republic of Serbia, through the project: "Innovative scientific and artistic research from the FTN activity domain".

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Industry 4.0 Enablers: Implementation of Organizational Concepts as a Support for Technological Improvements of Manufacturing Companies

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Abstract. Research related to the Industry 4.0 is mainly oriented towards the use of advanced manufacturing technologies that are considered as enablers of this new manufacturing concept. The importance of organisational aspects in this context is starting to get recognised, but there is a lack of empirical research that supports these claims. This paper aims to go one step backwards and to analyse the relationship between the implementation of organizational concepts and technologies that are vital for manufacturers aiming to introduce Industry 4.0 concept. The analysis is based on the dataset collected from 240 Serbian manufacturing companies in 2018 through the international project European Manufacturing Survey. Using the regression analysis it is revealed that utilization of concepts related to organisation, management, and controlling of production have a positive impact on the implementation of advanced manufacturing technologies in companies. This paper highlights the complementarity between organisational and technological aspects of production and their relevance for manufacturing companies. Furthermore, this paper provides empirical evidence on the use of organisational concepts and advanced manufacturing technologies in manufacturing companies from a transitional country, thus opening a debate for those researchers and practitioners interested in research related to transitional economies.

Keywords: Industry 4.0 · Organisational concepts · Advanced manufacturing technologies · Digitalization

1 Introduction

Current technological trends and increasing global competition have resulted in the intensification of requirements to more effectively allocate the resources while implementing novel technologies and processes. Based on technological advances and implying the significant alteration of the manufacturing environment, the new manufacturing paradigm labeled Industry 4.0 has gained substantial attention in the academic community [1, 2]. Since the term Industry 4.0 had been introduced, it was observed that its impact goes

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 170–175, 2022.
http://doi.org/10.1007/978-3-030-97947-8_23

far beyond manufacturing sector, having various socio-economic effects. In this view, it is reasonable that obtaining an unambiguous definition of Industry 4.0 concept is not an easy task, yet it could be stated that Industry 4.0, also termed the fourth Industrial revolution, is "a set of technologies based on the digitization and interconnection of all production units present within an economic system" [3]. It implies interconnectedness of the whole value chain and data that enables the emergence of smart manufacturing and delivers integration across the whole manufacturing value chain [1, 4].

Among the numerous aspects and implications of this transformational paradigm, technological innovations are viewed as key enablers of the Industry 4.0 manufacturing landscape [5]. Since they are positioned at the core of production transformation and enabling the digitalization of processes, implementation of novel technological concepts has been in the focus of many researches that have highlighted the positive impact of technological improvements on the overall company's performance [6, 7].

However, many researches point out the significance of organizational aspects attributed to administrative and managerial sector, since the application of adequate organizational concepts could be viewed as the prerequisite for the successful implementation of technological concepts [8–10].

The relationship between organizational and technological factors have been studied from various aspects, as well as their combined contribution to the firm's performance [11]. There are numerous implications of the complex nature of technological and organizational relationship. Some of the previous researches suggest that the organizational innovations serve as a facilitator for the successful implementation of novel technology [12]. The impact of implementation of organizational aspects could be considered as highly important for sustaining of competitive advantage.

As organizational innovation is multifaceted and encompasses novel practices in the domain of firm's strategy, structure and procedures that are affecting the overall processes and outputs, the question of interdependence of technological and organizational concept should be considered to be as an important issue in the both developed and developing countries. It is expected to experience a certain level of hindrance in the process of advanced technologies adoption, with the tendency for this process to be even more challenging in the emerging economies, who are historically lagging behind in this domain [6]. The main corpus of research regarding the aforementioned topic deals with developed economies that have higher extent of adoption of Industry 4.0 enabling technologies. Some scholars argue that there is a different adoption model of Industry 4.0 concepts depending on the economic environment, i.e. developed or emerging economy [1, 13]. Since many transitional economies are still to implement the majority of Industry 4.0 relevant concepts, it is important to investigate whether the implementation of certain organizational concepts has a positive impact regarding the adoption of advanced technologies in manufacturing landscape of emerging economies.

2 Research Hypothesis

Based on the above described findings from different researches that recognize the relevance of association between the organisational and technological aspects of manufacturing companies, the hypothesis considered in this paper are as follows:

H1: The implementation of organizational concepts related to Organization of production has a positive impact on the use of advanced manufacturing technologies.
H2: The implementation of organizational concepts related to Management and controlling production has a positive impact on the use of advanced manufacturing technologies.
H3: The implementation of organizational concepts related to Human resource management has a positive impact on the use of advanced manufacturing technologies.

For the analysis of proposed hypothesis, we used the model presented in Fig. 1.

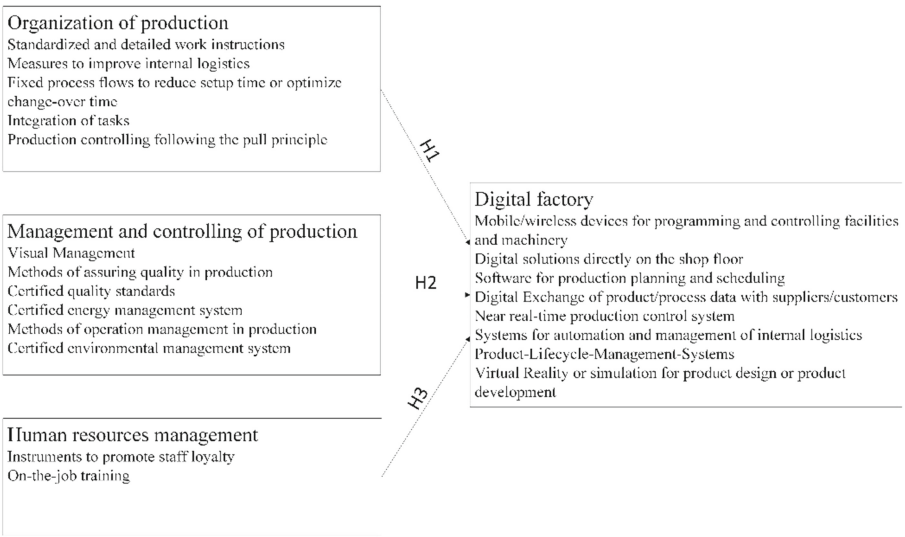

Fig. 1. Proposed research model

3 Methods and Data

For the purpose of this study we used statistical analysis. More specifically, our analysis on the relationship between the implementation of organizational concepts and the use of digital technologies in Serbian manufacturing companies is based on the results obtained by employing linear regression. The data for the analysis is gathered through a survey that is carried out under the international project European Manufacturing Survey (EMS), coordinated by the Fraunhofer ISI Institute from Germany. EMS is mainly focused on technological and organizational innovation in manufacturing companies, but other aspects of manufacturing processes are also considered [14–16]. The survey is conducted each three years and targets manufacturing companies (NACE Rev 2 codes from 10 to 33) with more than 20 employees. The dataset used for the analysis in this paper is gathered from Serbian manufacturing companies and includes 240 responses from 2018 round of the survey. The dataset includes about 46% small companies having between

20 to 49 employees, another 43% of companies that have between 50 and 249 employees representing medium-sized companies, and last 11% of the companies having more than 250 employees thus belonging to the group of large companies.

Companies were asked about the organizational concepts (i.e. organization of production, management and controlling of production, and human resource management) and technologies (i.e. digital factory) that they currently use. We used this information to determine whether there is any positive impact of the implementation of organizational concepts on the use of digital technologies.

4 Results and Discussion

The results aimed to present the relationship between the implementation of organizational concepts and the use of digital technologies in Serbian manufacturing companies are depicted in Table 1.

Table 1. Results of the regression model

	Digital technologies
Organization of production	.262**
Management and controlling of production	.210*
Human resource management	.089
R	0.470
R^2	0.211
F	22.359
Sig	0.000

Note: $^{**}p < 0.001$; $^{*}p < 0.01$

The results aimed to present the relationship between the implementation of organizational concepts and the use of digital technologies in Serbian manufacturing companies are depicted in Table 1. In regression model that tests hypothesis developed for the purpose of this research, the overall model was significant, adjusted R2 = .211, F = 22.359, p < .001. Two predictors had a significant coefficient – Organization of production (B = .262, p < .001) and Management and controlling of production (B = .210, p < .01), while the third predictor Human resource management did not show any significance in the model. These results are in line with prior research in the field that claim the complementarity between implementation of organizational concepts and technologies in manufacturing [9]. More precisely, our analysis shows that organizational concepts that are directly related to the production processes are positively influencing the use of digital technologies in manufacturing companies. This is not the case with human resource management which tends to support the use of digital technologies in the indirect way [17, 18].

5 Conclusion

The main objective of this paper is to determine the impact of organizational concepts as a support for successful implementation of novel technological concepts in manufacturing companies. The results are based on a sample of 240 Serbian manufacturing companies, the data being obtained through the 2018 European Manufacturing Survey edition with the aim to provide information on the extent of usage and implementation of technological and organisational innovations in manufacturing sector. The results indicate that implementation of organizational concepts related to organization, management and controlling of production has a positive impact on the use of advanced manufacturing technologies, that is in line with the findings of authors that emphasize organizational aspects as key enablers for successful technological innovations within manufacturing companies.

These results could be of use for managers and practitioners for their strategic orientation concerning improvements of production processes, especially for those located in emerging economies that are faced with greater challenges on the path to digitalization and more extensive application of Industry 4.0 concepts.

We have limited this research to analysis of the manufacturing industry in general. Other relevant determinants for deeper analysis include the size of the company, as well as the specific manufacturing sectors. The future line of research could also include consideration of additional factors pertinent to manufacturing environment of transitional economies.

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Maintenance- and Strategic Physical Asset Management: Morphologies of Two Connate Concepts

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Abstract. This paper aims to examine the relationships and delimitations between maintenance management (MM) and physical asset management (AM) concepts. There are several standards, e.g., ISO 5000*, DIN 31015, and DIN EN 13306, which define the basic terms connected to maintenance and asset management. However, they lack a clear differentiation between the two terms, and in the scientific literature, they are often used interchangeably. To gather an in-depth understanding of the usage of the two terms, a literature review (LR) was conducted based on different search strings around MM and AM. Using the principles of Design Science Research (DSR), a model was created to describe the morphologies of companies on the spectrum from MM to AM. For validation, data from assessment- and optimization projects with Austrian and German industrial companies in the fields of MM and AM was used. The results are a proposal for a differentiation scheme by the authors and a classification method that helps to understand the differences between MM and AM.

Keywords: Maintenance management · Industrial asset management · Engineering asset management · Physical asset management · Industrial management · ISO 55001

1 Introduction

Between 1850 and the beginning of the 20th century, maintenance was not carried out by specially qualified staff, but by the machine operators themselves. Maintenance operations at this time were mainly characterized as "Breakdown Maintenance" and presented maintenance as mere necessity and cost factor within production facilities. Within the second industrial revolution and the division of labor (Taylorism), the first maintenance manuals, which included maintenance and inspection plans, were created. Triggered by the economic upturn in the industrialized countries after the Second World War, "Preventive Maintenance" became the center of discussion. With the "Total Productive Maintenance" (TPM) philosophy, elimination and avoidance of losses in the organization turned into a central pillar in MM. In the 2000s, Reliability Centered Maintenance

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 176–184, 2022.
http://doi.org/10.1007/978-3-030-97947-8_24

and Risk-Based Maintenance were introduced. Furthermore, performance measurement became more and more important. Due to the ever-increasing automatization within the manufacturing and producing industry, a holistic perspective on the maintenance process (MP) gained more and more importance [1, 2]. Higher competition, turbulent business environments, the shorter economic life cycle (LC) of production assets in certain branches, sustainability issues, and higher expectations concerning the profit by the shareholders, are just some of the current issues that industrial companies face. These issues translate into the need for a long-term increase in capital productivity, emphasizing the need for the LC value creation as an investment criterion. In combination with overcapacities in many branches and inflexibilities in certain cost factors (e.g., labor), capital-related factors and optimizing them, become more important [3]. The first approach to standardization of different AM aspects (e.g., LC strategy, maintenance activities) was published by the British Standards Institute (BSI) with the PAS 55-1 in 2008. PAS 55 serves as the basis for the international standard for AM ISO 55000 [1]. Through the smooth transition between MM and AM, it is very difficult to find a clear distinction between these two management concepts, which led the authors to write this paper [1, 4, 5]. The paper is divided into five sections. After a brief introduction and the historical background in section one, the theoretical background is discussed in chapter two, followed by the development of the morphological box in section three. The results obtained are presented in part four and discussed in the final section, where also an outlook on further research is presented. It is important to state that this paper and the history of maintenance, as presented before, is based on a literature study, empirical data is only used for the validation of the usability of the created model.

2 Theoretical Background

In this section, the terms of MM and AM are elaborated, defined, and objectives, typical processes, and tasks are discussed. The MM section focuses on existing standards, as the term is already well defined, while the AM section focuses on recent scientific literature, as it is a relatively new term compared to MM.

2.1 Maintenance Management

A definition of maintenance within the European industry did not exist until 1974 when the German Institute for Standardization (DIN) published the DIN 31051 "Maintenance; Terms" [6]. DIN defined maintenance as a "*combination of all technical, administrative and managerial actions during the life cycle of an item intended to retain it in, or restore it to, a state in which it can perform the required function."* Furthermore, the term MM was defined as *"all activities of the management that determine the maintenance objectives, strategies and responsibilities, and implementation of them by such means as maintenance planning, maintenance control, and maintenance activities and economics"* [7]. The British Standards Institute (BSI) defined maintenance as *"a combination of all technical and associated administrative activities required to keep an equipment, installations and other physical assets in the desired operating condition or restore them to this condition"* [8]. Within the standard definition of maintenance objectives, one focus

is set on (physical) asset value preservation, which also includes the consideration of the equipment or system over the entire LC. DEKKER divided the maintenance objectives into ensuring system function/-life/-safety and human well-being [9]. In DIN EN 13306, the main objectives are, *"the availability of the item to function as required, at optimum costs; consider the safety and any other mandatory requirements associated with the item; to consider any impact on the environment; to uphold the durability of the item and/or the quality of the product or service provided considering costs where necessary"* [7]. The definitions of the MM main objectives imply an item or asset-centered view as well as a total system-view. Achieving higher productivity and increase safety, maintenance objectives, strategies, and measures have been more and more influenced and adapted by the company's strategic alignment, policy, and production plan. Hence MM is required to achieve the desired output, availability, and quality of the production. The future viability of manufacturing companies is given when MPs are defined, implemented, and continuously performed [8]. In 2017, the DIN EN 17007:2017 was published, which focuses on the MPs, their structure, and controlling and monitoring aspects. Key MPs are service, inspection, repair, and asset improvement [10]. Several authors already defined the integration of MM within AM between 1978 and 2010 [11–13], and with the DIN EN 16646:2014, the connection between maintenance and asset management was standardized [14].

2.2 Asset Management

The Oxford English Dictionary defines an asset as *"an item of property owned by a person or company, regarded as having value and available to meet debts, commitments, or legacies"* [15]. The term "asset" can be clarified by describing it as something that can create and sustain value, when in use, or that appreciates or depreciates, due to a perceived ability to create value in the future, or as the ISO 55000 defines it, as, *"an item, thing or entity, that has potential or actual value to an organization"* [16, 17]. The term asset was, and still is, primarily used in the context of financial assets, e.g., stocks, funds, and other purely economic assets [18–20]. However, assets can take different forms; they can be physical-, financial-, human-, information-, or intangible assets. Examples for physical assets, which are at the center of this research are industrial plants, types of machinery, buildings, vehicles, railways [21]. In the industrial context, which is relevant to this paper, two terms that are used interchangeably, are currently in use: engineering AM and physical AM. In this paper, however, the authors refer to the term AM [22]. AM can be defined as, *"The system that plans and controls the asset-related activities and their relationships to ensure the asset performance that meets the intended competitive strategy of the organization"* [23]. This definition already implies the holistic view of AM, namely that it encompasses a comprehensive system control of asset-related activities that are directed at achieving the organizations' goals and an LC perspective AM takes on the management of those assets [24, 25]. Furthermore, the definition of AM can be extended by including all those practices and activities that are needed to optimally, sustainably, and risk-oriented manage an asset [26]. AM includes both technical and business activities that concern the asset, and if AM is seen at the corporate level, it should be part of the overall strategic management [27, 28]. Concluding, a cultural dimension of AM is also acknowledged in the literature [29].

AM includes practices and processes, from the corporate level, via the plant level to the sub-process/equipment level [18]. The requirements for ISO 55001 compliance are grouped into seven categories or processes, e.g., leadership, planning, and improvement, which are also divided into several sub-processes [17, 30]. Another grouping of the AM processes can be obtained by looking at typical life cycle stages of an asset. A possible differentiation could look as follows: strategy, planning, evaluate/ design, create/ procure, operate, maintain, modify, and dispose of. The goals of these processes can be described as identifying what assets are needed, identifying funding requirements, acquiring assets, providing logistic and maintenance support for assets, and disposing and renewing assets [21]. Other authors have separated AM decisions into decisions around capital planning and budgeting, or CAPEX and decisions around the operating budget, or OPEX [21, 31]. Furthermore, the tasks of AM include strategic planning around developments in the business and asset situation, e.g., monitoring of trends, technological developments, risk factors, asset performance and condition of the assets, and outsourcing [21]. Summarizing, the classical maintenance manager differs from the asset manager in his responsibilities and tasks [31].

3 Morphologies of MM & AM

This section represents the morphology and the proposal of the model itself with its different attributes from the literature. The research design of this paper is built on the principles of Hevners' DSR methodology, where the major goal was to create an artifact to describe the morphologies of companies on the spectrum of MM to AM. The requirement for the model was to find a clear distinction between MM and AM. To satisfy the rigor cycle, an LR was carried out in the beginning to gain the theoretical background necessary for developing the model. The model was designed by incorporating the findings during the LR and re-evaluated, whenever the authors' knowledge base was enhanced by new literature. Data from international companies that have production or manufacturing facilities in Austria and Germany were used to validate the usability of the designed model. The goal was to create a simple differentiation based on a limited number of easily visible aspects that, however, sufficiently describe the key differences between these two organizational options, as perceived by the authors of this paper and as shown in Table 1. The attributes, on which MM and AM are differentiated, reach from very general descriptions of key activities to the competencies and functions of the maintenance-, respectively, asset manager. The morphology indicates that the characteristics of AM are more in alignment with general organizational objectives concerning strategic planning, risk orientation, and value creation than those of MM. The authors claim that only a specifically qualified manager enables an organization to transition from an MM to an AM system fully. The AM manager must be capable of leading and implementing the transformation of new organizational structures and processes. It is noteworthy that these structures and processes necessitate objectives on a higher level of abstraction than the MM system requires.

Table 1. MM – AM morphology

Nr		MM	AM
1	Key Activities	Techn. actions, planning, documentation	Org. actions, planning & controlling,
2	Objectives	Maintenance-related objectives	Manage an asset optimally and sustainably, important items being asset expenditures, performances and risks to achieve the organizational strategic plan
3	Personnel Competencies	Functional teams, technical competences	Multi-disciplinary teams
4	Focus on	OPEX	CAPEX + OPEX
5	IT-System	Computerized maintenance management system (CMMS)	Enterprise Asset Management (EAM)
6	LC	Planning, evaluate/design, create/procure, operate/maintain/modify	Strategic AM Plan (SAMP) as a starting point, risks addressed when planning for the AM system, AM objectives derived from SAMP, Disposal Phase part of AM
7	Org. Intersections	Functional	Cross-functional
8	Perception	Cost factor	Contributor to value creation
9	Scheduling	Based on static maintenance strategies	Based on external factors, dynamic maintenance strategy adaption
10	Stakeholder consideration	Only internal	Internal & external

(*continued*)

Table 1. (*continued*)

Nr		MM	AM
11	Sustainable Orientation	Long-term success factors For the maintenance organization	Through corporate alignment
12	Weak Point Analysis	Focus technical	Also organizational
13	Hierarchical Position (Manager)	Mid-level management	Positioned at C-Level, or staff position
14	Key Competencies (Manager)	Technical/social/problem-solving/organization-specific competencies	Strategic/integrated thinking, decision making, risk evaluations
15	Functions (Manager)	Mostly operative	Mostly strategic

4 Results

Based on the defined attributes, the authors chose four companies, whereby one from the chemical- (A), metal- (B), electronic- (C), and raw material (D) industry. The morphologies of the companies, which can be viewed in Fig. 1, are based on company information available to the authors from past projects, and benchmark data from the Maintenance Award Austria. Besides the different fields of operations, the number of employees within the maintenance department varies between 14 and 100, and the monetary asset value ranges from 25 to 550 Mio €. The differences between the companies enabled the authors to validate the usability of the presented morphology.

Company A, as the smallest company concerning the number of employees within the maintenance department, represents a firm that is currently in transition. Due to the strong growth of the company, management has recognized the need for improvement to develop from a maintenance organization (MO) to an AM organization (AMO). The morphological profile of B, a company with constant sales, uncoupled from economic cycles, represents that of a classical MO. Company C, as representative of the electronic industry, faces strong international competition, which is why C has decided to implement AM. The AMOs' morphology reflects this strategic decision. Company D is transitioning from MM to AM and has started doing so by expanding the managers' competencies.

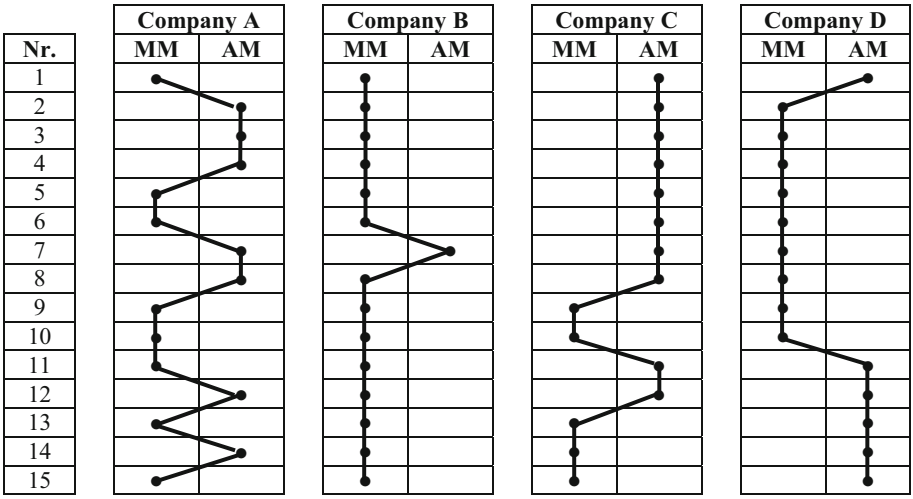

Fig. 1. Application of the MM & AM morphology

5 Discussion and Outlook

In this paper, an approach to differentiate between MM and AM was introduced. Coming from an LR and using DSR, the authors have created a morphology that visualizes the proposed differences concerning certain items of the two management concepts. The usability of the model was validated by using company data from four different companies from Austria and Germany, that represent different branches and sizes of MO and AMO. Further steps on the research agenda are a verification of the proposed model by independent experts and a comparison with job descriptions of maintenance- and asset managers by different companies. Moreover, validation with a higher number of companies is necessary. The authors do not claim exhaustiveness of the model; the attributes in the morphology represent only a selection of well and easily definable properties. Nevertheless, the model enables researchers and practitioners to quickly assess organizations and define, where they can be found on the spectrum from a classical MO to a holistic AMO.

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Digital Marketing in China - Weibo and Fan Economy

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Abstract. During the previous decade, People's Republic of China undoubtedly became one of the main drivers of digital marketing in the World. Digital marketing trends in China move so quickly that it is quite hard for foreign companies to keep up. With the booming of mobile devices, social platforms have changed the way how people communicate and play an important role in daily life, stimulating the growth of social media marketing. Sina Weibo, as one of the major social media platforms in China, also acts an influential digital marketing channel having almost 400 million users. This paper focuses on the difference between non-fan and fan users in order to analyze the target audience and classify Sina Weibo users into various fan levels. The results are related to user pattern, including the preferred features, purchasing behaviors on Sina Weibo VIP membership, of non-fan users and fan users (in different fan levels) and how it would affect the marketing practice on Sina Weibo. This paper provides a new perspective on Sina Weibo user behavior analysis, gives a clear definition of non-fan and fan users and discuss the difference in their user pattern. The findings are very valuable for marketers and companies from China and abroad, especially from the Belt and Road countries, interested in digital marketing in the largest market in the World. In order to effectively promote in China, it is crucial to better understand users on Sina Weibo and lay the foundation for future successful Sina Weibo marketing campaign.

Keywords: Sina Weibo · Fandom · Fan economy · User behavior · User pattern · Belt and road initiative

1 Introduction

With the widely use of Internet and other new technologies, marketing has experienced a shift of focus from traditional marketing relying on channels including TV and paper media to digital marketing represented by Internet marketing and email marketing. Digital marketing is no longer a "new term" for both marketers and general public. With the booming of mobile devices, social media platforms have changed how people communicate and play an important role in daily life, stimulating the growth of social media marketing.

Sina Weibo, one of the major social media platforms in China, has been frequently mentioned and analyzed in paper regarding to digital marketing in China [1]. Meanwhile,

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 185–192, 2022.
http://doi.org/10.1007/978-3-030-97947-8_25

the scale and impact of fan economy has witnessed an exponential growth and fans have created a new market that no company or brand wants to lose. Several scholars have researched on content strategies and marketing patterns and psychology strategy, providing insights on Sina Weibo marketing [2]. Yet few researches mentioned about the concept of "fan economy", combine "fan economy" into Sina Weibo marketing and conclude how it impacts marketing practice on Sina Weibo.

The research problem that this paper analyzed and discussed is about how non-fan and fan users (with a broader concept) use and behave on Sina Weibo and whether there is an obvious difference in the user pattern of users in various categories. The research goal is to provide a new perspective for Sina Weibo user behavior analysis, give a clear definition of non-fan and fan users and discuss the difference in their user pattern.

By reviewing materials and secondary data, the development of fan economy: a case study of Super Girls in 2004 to 2006; start of mobile digital age: the emergence of social media platforms from 2009 to 2012; the mechanism to trigger fan economy in 4G era and how Sina Weibo adopted different strategies (140-world limit per post, introduce the concept of fan, encourage influencers) to attract users in its early phase is discussed and summarized.

Also, based on [3], non-fan and fan users (in different levels) are defined in several aspects. Through survey analysis, the results show that besides the major features of posting, commenting and reposting, non-fan user or users in lower fan level (follower fan user) prefers features that enable to acquire information while higher-level fan users, pay attention to interactional features and are more engaged with online friends. Also, there is great difference between the purchasing behavior of Sina Weibo VIP membership and evaluation of Sina Weibo in non-fan and fan users.

2 Digital Marketing and Fan Culture

2.1 Digital Marketing and Sina Weibo

According to [4] digital marketing is defined as "the ability to interactively communicate with customers through electronic channels, such as the web, e-mail, smart devices such as phones and tablets, and mobile applications". A previous survey on US digital marketing spending [5] indicated that the four most recognized techniques of digital marketing are social, mobile, analytics, and e-commerce.

Previously, communication between companies and their potential customers was associated mainly with a monologue delicately prepared by firms through traditional marketing tools (e.g. adverts, sales promotions, etc.). Nowadays, the Internet allows individuals to communicate directly with companies and vice versa; in the way the characteristic of marketing communication has changed from a one-way to becoming a two-way process.

Launched in April 2011, Sina Weibo is a micro-blogging platform and also one of the largest social media platforms in China with over 203 million daily active users according to Sina Weibo Quarterly Statement Q1 2019 and about users of Sina Weibo covered 42.3% of overall 829 million Chinese netizens [1].

According to [6] "microblogging is the key feature of social media platform that allows users to broadcast short messages to friends and followers, ensuring frequent and immediate updates on their activities, opinions, and status."

There is an obvious trend that digital channel including Sina Weibo becomes more and more crucial in terms of marketing performance. Paper [7] researched on movie market and the paper concluded online word-of-mouth via social media has an impact on customer's motivation to enter cinema. The results showed that social media had "the broadest influence on consumers' intrinsic motivation".

2.2 Roles of Fan in Digital Age

In digital age, users can easily become others' fans or followers by clicking the button of "subscribe" on a certain social media page. However, some scholars claim that becoming a real fan is actually more demanding.

Authors in [8] gave their opinions that maintaining one's identity as a fan is "a demanding and often demeaning task—rather than a choice—that is not always as fulfilling as the content that fans love to consume."

3 Review of Fan Economy in China

Fan economy refers to an income-generating behavior, which based on the relationship between fans and followers. It is a business operation mode that can enhances user stickiness and obtain economic benefits, social benefit in the form of word-of-mouth marketing. The development of fan economy in China experienced three most important periods: Period 1: From 2004 to 2006 - Booming of TV Talent Show: a case study of Super Girls, Period 2: From 2009 to 2012 the start of mobile digital age: the emergence of social media platforms and Period 3: 2012-Till now 4G era – Mechanism to trigger fan economy.

During the Period 1, only 7.5% of Chinese citizens had internet. And TV talent show "Super Girls" introduced the idea of "fan economy" to China's market. There were 150,000 girls signing up and over 400 million audience [9]. As for Period 2 from 2009, a lot of celebrities were invited and attracted to create a Sina Weibo account. Users in Sina Weibo can communicate freely with celebrities and other users; they could post pictures, videos and comments on their homepage; they also could "like" other users. WeChat is another popular application in mobile digital age, as a tool to send messages to friends and family members. [10]. After 2012, 4G opened new opportunities for Sina Weibo, and Sina Weibo had undoubtedly become the largest platform for public opinion gathering and distributing in China. Sina Weibo has been formed a complete mechanism to trigger fan economy: directly input from influencers and bloggers – directly receive from audiences and fans - establish relationship through communication on Sina Weibo – blogger open a e-shop or send product information – fans purchase.

4 Survey Analysis

To better understand the difference of Sina Weibo users in various levels, survey analysis is conducted to collect more data and information from users' views. Through the analysis

of existing materials, which provided background of the research, the survey questions are designed to gather relevant data in order to solve the problems: how to define a fan and how to reflect the user pattern through answering questions.

The questions in the survey included the following parts: demography, how to define a fan and user pattern.

Some scholars have noticed the diffidence between obsessive groupies or fanatics and fans in modern day who are active in digital platform. Concept of "ideal, modern-day fan", as "a balanced individual who advocates for the product within their own extensive network" was proposed in [3].

The difference between follower users and non-fan user is based on the respondents' respond on certain question in the survey that is "In your interested topic, do you continuously follow one or some influencer on Sina Weibo?" If the respondent's answer is "no", he or she will be labeled as a non-fan user in our analysis. Although the subject of [3] is confined to fans of a brand or a product, it gave insights to our analysis on how to define and classify fans. Based on the previous analysis, several levels of fans, from follower to high-level fans are defined in Table 1 below.

Table 1. Definition of fans in different levels.

Fan Level	Action	Emotion	Interaction
Follower	Click "follow"	a. Create alert to track the latest post b. Join in fan group on Sina Weibo	a. Participate in online activities or events organized by fan group (e.g. online voting) b. Willing to support the influencer financially
Primary-level fan	Feel positive to most posts	a. Feel excited to see latest update b. Willing to interact with other fans	a. Sense of achievement from participation b. Feel negative of the critics and willing to defend for the influencer
Intermediate-level fan	Prefer to click "like" on post	a. Comment on several posts b. Willing to express the appreciation of favorite influencer on his/her own social media page	a. As primary fan-as-creator, create contents and share to public in order to attract attention and favor from other audiences b. Tend to believe the content from the influencer
High-level fan	a. Organize online events in fan group b. Participate in several offline activities c. Willing to purchase cultural products from the influ-encer	a. Sense of responsibility of fan group b. Passionate to created content related to the influencer c. Sense of achievement from support and appreciation given by other fans	a. Develop his or her own skills or seek assistance from own resources to support the influencer b. A professional fan-as-creator, created contents that are acknowledged by other fans c. High in fan community hierarchy with own followers

4.1 User Pattern

An analysis in the user patterns and motivations of Weibo was conducted in [11]. The designed survey listed 40 motivations of using Sina Weibo and asked the respondents using the phrase "I use Sina Weibo _____" and to rank these motivates from 1 (strongly disagree) to 7 (strongly agree). In our analysis, the data from the section of user pattern of questionnaire is going to answer: preference on Sina Weibo's feature, time spent on Sina Weibo per day, frequency to post original content, number of users that the respondent follows, the interested topic, purchase experience of VIP membership and motivations and evaluation of the App.

5 Research Findings

The survey was assigned to random online users on WeChat and Sina Weibo and the language of the questionnaire was Chinese. The whole sample could be divided based on gender and age and 336 responses were received.

5.1 Separate the Samples

In previous chapter, the action, interaction and emotional behaviors of fans in different are clearly defined. For question "Whether you have continuously followed one or more influencers on Sina Weibo?" Samples with answer "No" are classified as non-fan users. The rest are fan users. To define the level for each sample, the authors calculated the weight based "fan index" for each sample.

The score of weight for each option are shown in Table 2 below. The respondent chose the behaviors (in the aspects of action, emotion and interaction) which conform to their own user behavior as a fan.

The calculation of fan index is based on the following formula:

$$fan\ index = \sum_1^{n_1} w_{n_1} * action_{n_1} + \sum_1^{n_2} w_{n_2} * emotion_{n_2} + \sum_1^{n_3} w_{n_3} * interaction_{n_3} \tag{1}$$

n_1 : *the numbers of acion factor selected*; n_2 : *the numbers of emotion factor selected*; n_3 : *the numbers of interacion factor selected*; w : *the weight of the selcted factor*

Based on the fan index: samples with index of [1, 3] are classified as follower users; samples with index of [4,15] are classified as primary-level fan users; samples with index of [16,27] are classified as intermediate-level fan users; samples with index higher than 27 are classified as high-level fan users.

Based on respondent's responses on these questions, they are divided into these five categories for in-depth analysis, as 116 non-fan users, 31 followers, 75 primary-level fans, 61 intermediate-level fans, 53 high-level fans.

Table 2. Weight scores of different factors.

Action factors	Emotional factors	Interaction factors	Weight
Click "follow"	Feel positive to most posts	Prefer to click "like" on post	1
Create alert to track the latest post	Feel excited to see latest update	Comment on several posts	2
Join in fan group on Sina Weibo	Willing to interact with other fans	Willing to express the appreciation of favorite influencer on his/her own social media page	3
Participate in online activities or events organized by fan group	Sense of achievement from participation	As primary fan-as-creator, create contents and share to public in order to attract attention and favor from other audiences	4
Willing to support the influencer financially	Feel negative of the critics and willing to defend for the influencer	Tend to believe the content from the influencer	5
Participate in several offline activities	Sense of responsibility of fan group	Develop his or her own skills or seek assistance from own resources to support the influencer	6
Willing to purchase cultural products from the influencer	Passionate to created content related to the influencer	A professional fan-as-creator, created contents that are acknowledged by other fans	7
Organize online events in fan group	Sense of achievement from support given by other fans	High in fan community hierarchy with own followers	8

5.2 Key Findings

Different Preferences in Sina Weibo's Features. Results show that the major features of Sina Weibo: update posts and generate contents and interact with other users (comment or repost other posts) are ranked in top 5 in every category of users. In addition to major features, the figures show that non-fan user or users in lower level (follower fan user) prefers features that enable to acquire information, including check out the "most searched hashtags" and hottest topics and search for information (for certain product, person, recipe, etc.).

In contrast, higher-level fan users, who have joined in fan club or group on Sina Weibo, pay attention to interactional features and are more engaged with online friends, including check out Sina Weibo Friend Circle. Their participation in fandom strengthens their needs to communicate and socialize with other fans and friends on Sina Weibo and thus explain their dependence on the interactional features on Sina Weibo.

Different Attitudes Towards Sina Weibo VIP Membership. The figures show that non-fan users are reluctant to pay for Sina Weibo VIP membership and only 2% of them have purchased Sina Weibo VIP membership. However, an extremely high proportion of fan users investigated in this survey have purchased Sina Weibo VIP membership (80% in follower, 98.6% in primary-level, 100% in intermediate-level and high-level). The most mentioned reasons include enjoying label of VIP (28%), blocking ads (21%) and personalized setting (20.9%), indicating that over 21% investigated VIP member paid for less or no ads on Sina Weibo.

Although the aim of questions related to these questions were to find out whether users would like to pay for VIP to block the ads, the result reflects more information:

there is an obvious trend that users in higher fan level are more willing to purchase Sina Weibo VIP membership, and raise a new question: why fan users would like to pay for VIP membership.

Satisfied vs Unsatisfied. Nowadays, Sina Weibo has become one of the most influential social media platforms in China, strategies of Sina Weibo seem to be successful, but it does not 100% lead to a promising future. For marketer, it is important to understand the weakness and complaints about Sina Weibo when investing in this digital marketing channel and this survey has analyzed whether users (and which groups of users) are satisfied with the service of Sina Weibo.

Based the collected data, the attitudes and evaluations from fan users and non-fan users have a great difference. Generally, non-fan users tend to be unsatisfied with Sina Weibo and only 4 respondents from 116 non-fan users gave a score over 5. In contrast, the evaluation from fan users, even in different levels, is relatively high. However, figures from survey shows that the top complaint about Sina Weibo is suspicion on truth and validity of information mentioned in 83 responses, followed by cyberbullies, lack of privacy protection and excessive ads.

6 Conclusions

Social media marketing now plays a more and more vital role in brand's digital marketing campaign, especially in Chinese market. However, without understanding the users, it is still difficult for marketer to reach the audience and launch a successful campaign. This paper would like to conduct a further analysis and solve the problem that whether non-fan and fan users (in different fan levels) have a different user pattern on Sina Weibo.

With survey analysis, it is concluded that besides the major features of posting, commenting and reposting, non-fan user or users in lower fan level (follower fan user) prefers features that enable to acquire information while higher-level fan users, pay attention to interactional features and are more engaged with online friends. Also, there is great difference between the purchasing behavior of Sina Weibo VIP membership and evaluation of Sina Weibo in non-fan and fan users. Based the collected data, the attitudes and evaluations from fan users and non-fan users have a great difference. Generally, non-fan users tend to be unsatisfied with Sina Weibo and only 4 respondents from 116 non-fan users gave a score over 5. In contrast, the evaluation from fan users, even in different levels, is relatively high, over 7 of 10.

Based on the results and analysis, 6 recommendations are made for marketers or scholars who are interested in Sina Weibo marketing:

1. When targeting non-fan users or users in lower fan level (follower fan user), it is recommended to gain brand or product exposure via "most searched hashtags" and hottest topics, and word-of-mouth marketing.
2. The majority of these users paid for premium features including blocks ads keywords. It is recommended for marketers to first analyze the motivations for fan users to paid for VIP membership and in case the ads are blocked by these users.

3. Time actually spent on Sina Weibo tends to be longer than the time the user perceives to spend on Sina Weibo. When analyzing user pattern, it is recommended to collect the real data instead of directly asking the user. The potential factors for difference between the actual and perceived time may include user's emotion, user experience design, etc.
4. It is found that there is a great different in the satisfaction of Sina Weibo between non-fan and fan users. Thus, it is important to further analyze the reasons for non-fan users' dissatisfaction and whether these complains would lead to a potential user churn on Sina Weibo.
5. It would be meaningful to analyze the motivation and user pattern of influencer users to explain why they chose to communicate with followers via Sina Weibo instead of other social media platforms, and whether they are using feedback data collected by Sina Weibo to improve their contents and attract more fans.
6. This paper did not draw conclusions on the age groups in different fan levels. Thus, it is also valuable for future scholars to analyze the difference between fan users in different age group.

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Automating Multidimensional Security Compliance for Cloud-Based Industry 4.0

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Abstract. Industry 4.0 is a concept emerged from technological advances in different fields, from expansion of cyber-physical assets to industrial internet of things encompassed with cloud-adoption that drives big data analysis and artificial intelligence applications. Innovating in such technological landscape imply higher risks both in information security and privacy as various cybersecurity threats exist in each technology. Therefore, the information security management system (ISMS) and system security plan (SSP) in industry 4.0 must manage multiple standards and regulations relating to different scope leading to multidimensional compliance problem.

Managing SSP compliance with standards or regulations that overlap in scope and evolve over time is based on assessing and documenting security controls. Relying on manual efforts while the complexity and scope keep increasing is inefficient and often not possible due to the lack of the cybersecurity resources.

The paper describes a process to create an industry 4.0 relevant SSP that can be automatically assessed for easier compliance management. In addition, a baseline SSP is created focused on security controls needed for industry 4.0 systems based on cloud environments.

The proposed approach suggests that automated security controls assessment and auditing can be achieved which enables continual improvement of the SSP and increased efficiency for any organization trying to manage security audits. As the presented baseline SSP can be easily customized following the described process, the baseline can be used by any organization as a starting point to create the automated security management for industry 4.0 systems.

Keywords: Cybersecurity · Security controls · Information security · ISMS · SSP · Industry 4.0 · Cloud

1 Introduction

To understand the cybersecurity challenges of industry 4.0, it is important to understand the variety of technologies included and the evolution of industry. The industry evolution is clearly shown in [1] with the following conclusions: industry 3.0 starts with the information age while industry 4.0 is evolving from industry 3.0 mostly with the cyber-physical systems in place. Information management [2] puts crucial role on data as it is in the core sense what enables the integration between the two worlds – physical and

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 193–200, 2022.
http://doi.org/10.1007/978-3-030-97947-8_26

cyber, and this integration is in the core of industry 4.0. As the cyber world in industry 4.0 is enabled to directly manage and control physical assets, there are higher associated risks as the consequences might impact the physical world in different circumstances. This also leads to creation of digital twins, or virtual replicas of the physical devices to run simulations before actual devices perform the actions in the real, physical world. All of this is leading to generation of huge amount of data with different volumes, variety and most importantly, criticality. Such amount of data is requiring cloud infrastructures while there are alternative and complementary approaches such as fog computing which may play a significant role in supporting big data applications, especially in industry 4.0 applications [3]. Cybersecurity challenges in fog computing are vast and orthogonal to cloud computing cybersecurity challenges and choice between cloud and fog is only one of the decisions in the industry 4.0 space. To summarize industry 4.0 components from [4], there are the following technical components that comprise an industry 4.0 solution: cloud computing, mobile devices, IoT platforms, location detection technologies, advanced human-machine interfaces, smart sensors, big data analytics and advanced algorithms, multi-level customer interaction and customer profiling, augmented reality, and wearables.

These numerous components lay the foundation for the main challenge for securing the industry 4.0: the system is composed out of a series of technical components, very different in nature, spanning across different fields of application from cyber-physical devices to cloud, versus securing a single technology. There are many research studies that try to enumerate the threat vectors, risks, and approaches to efficiently apply cybersecurity to referent architectures with examples of security controls applied. However, even though many studies have reported threats along with security controls for mitigation, there has been little research focused on end to end security providing compliance monitoring and automation. Since continuous monitoring is the way to ensure that particular security controls are well implemented, automation is necessary in such disperse and wide area of technology. The purpose of the present study is to define a methodology that would ensure cybersecurity of industry 4.0 systems taking into consideration a variety of such systems on one side, and lack of cybersecurity expertise on the other. As described, industry 4.0 system is composed of different technological components which altogether focuses the research question on how to respond to security assessments that use different security frameworks through automated security control assessment and compliance management.

The rest of the paper is organized in the following sections: section two describes related works; section three illustrates proposed solution and the process of building a reference cybersecurity framework, and at the end, section four summarizes the contributions of this paper and plans for future research.

2 Related Work

Approaches to compliance management are usually based on a manual effort, performed by cybersecurity professionals who maintain compliance evidence and perform internal audits to establish a relevant control process needed for continual compliance management. The presented research work is built on foundation of National Institute of Standards and Technology (NIST) cybersecurity risk management framework [5, 6] with aim

to provide guidance for an integrated, organization-wide program for managing information security risk to organizational operations, organizational assets, individuals, other organizations, but with important addition to keep track of risks associated with product development and system operations. Furthermore, NIST cybersecurity framework [7] is used as a self-assessment tool to help organizations better understand the effectiveness of their cybersecurity risk management efforts and is the key pillar for a process that will drive and ensure an end to end cybersecurity in industry 4.0. Moreover, the General Services Administration (GSA) partnered with NIST to create the Open Controls Security Assessment Language (OSCAL). The language describes security controls in a standardized and machine-readable format, and enables providers to express their system security plans, which describe how an organization has implemented the necessary security controls, in a machine-readable format. OSCAL enables automation in both the documentation and assessment of security controls [8]. The OSCAL documentation is given in [9], while the source code can be accessed publicly [10], and the project is also open for public contributions. As OSCAL is becoming an integral part of the research community, one of its authors [11] has described meta-schema of OSCAL language bringing more clarity to the design and intentions of the automation language.

OSCAL is foundational for this research, which is true also for the research presented in [12]. While the foundation is the same, the works are complementary as the authors created a tool based on OSCAL format with aim to specifically promote the enhancement of risk management by composing reports and graphs in different NIST defined domains, controls, and capabilities specification effectively. This helps to reduce development cost, time, and manpower by using the tool to quickly define information system security standards based on NIST's security and privacy guidelines [12]. Such tool is a logical next step for effectively using OSCAL formatted documents as it enables cybersecurity experts to manage the risks and requirements in an intuitive way using the tools built-in technical dictionary to implement established risk management procedures using applicable security controls. As a useful tool making the manipulation of OSCAL documents easier, this research [12] is complimentary to the work presented by this paper.

Since the security programs are built on risk management frameworks, a research presented in [13] relates to this research as the conclusions imply that there might be cybersecurity risks when common insecure industrial control systems (ICS) environments adopt industry 4.0. The findings also show that already existing technologies, once extended with other components in a system, need to be revisited as the cybersecurity of overall system is not a sum of cybersecurity of each component. The reason behind these conclusions reside in the fact that the security context for a component changes as it becomes a part of a system that includes more variety.

There is no generally accepted, and established methodology for assessing industry 4.0 readiness of enterprises [14], while the aim of this research is to offer one. The related work [14] gives an overview of industry 4.0 readiness assessments, and methods has been provided, showing some examples in more detail. The main idea is to provide a useful assessment process for the management of an enterprise so they can use the results of an industry 4.0 assessment as benchmarking information. This process would

have to include periodic assessments where the proposed methodology in this paper tries to give an automated solution for such assessments.

The paper [15] introduces a stepwise process that systematically extracts relevant security requirements from control standards to build a certification baseline for organizations to use in conjunction with formal methods and service agreements for accreditation. Central idea is the same as in this research and some of the ideas such as described internal system certification lifecycle are used to formulate the proposed process in this research. A security program that responds to different standards would benefit from using control mapping processes such as described in [15]. The interconnection between cloud-based systems and cyber-physical assets is explained in [16], originating in increased data and business intelligence solutions. Furthermore, as a Service models are briefly explained where it can be concluded that if an industry 4.0 system provider uses cloud to deliver the services, it becomes ultimately responsible for the data stored within the cloud instances which would mean that cloud security automatically becomes a part of the target SSP. Such requirements do bring privacy concerns as well as the vendor of software-based solutions have the access to the data which directly interconnects the organizations' information security management system (ISMS) with the SSP.

Finally, considering how often industry 4.0 systems are actually the main drivers behind ICS systems, the contributions of the paper [17] are of great importance as it connects the standards needed for ISMS implementation with standards that are used for SSP. Furthermore, it gives a brief overview of different ICS standards making it easier for ingesting requirements into the final SSP of an industry 4.0 system.

3 Methodology

The ISMS and SSP often overlaps within the organizations that are software providers. This is essentially true for companies that provide software as a service (SaaS) which is usually the case when cloud computing is used. Figure 1 shows a generic industry 4.0 system components that needs to be secured, but moreover, they must be securely integrated into the whole system that provides functionalities to the end users. If cloud computing is used, as a service business model is assumed which further implies that the vendor is responsible for software maintenance and the operations of the software. Operating the software application and being responsible for the ultimate availability of the service, the organization itself becomes a part of the cybersecurity supply chain where the integration of ISMS and SSP is inevitable as the ISMS controls needs to also include controls required by the target system and those controls need to cover technology, people and processes that deliver the service to the end users. Besides cloud computing, there are other components that might require remote access to software products by the vendor, as shown in Fig. 1.

Also, if cloud is used to provide SaaS offerings, the organization employees have access to customer data, and the access needs to be controlled and managed as it involves privacy issues. Thus, privacy programs are increasingly important in cloud based deployments. Besides the cloud component, the same implications are true in any of the component that is managed by the vendor, especially if the component itself is provided by the same vendor.

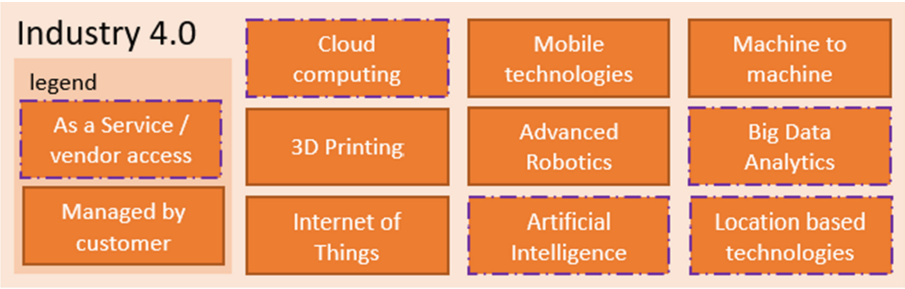

Fig. 1. Industry 4.0 components and cybersecurity operational liability

Figure 2 presents the proposed process for managing compliance in organizations that must comply with multiple regulatory frameworks. First, it is very important to properly identify security requirements by investigating which legal and regulatory security requirements are applicable in local laws and laws of countries where the customers and potential market is. Also, using business objectives and risks associated with the system that the organization creates, cybersecurity experts can determine the right control catalogs in step two.

The second step is dedicated to identifying security controls that may be selected from different security frameworks. In industry v4.0, the Table 1 helps in selection of baseline controls necessary for step three. The X marks a match for given component and framework family, while O stands for optional as it depends on the nature of data that is being processed by the industry 4.0 system like the personally identifiable information for GDPR. In modern industry 4.0 systems, GDPR and CCPA are very likely needed as the chances for processing sensitive data are high.

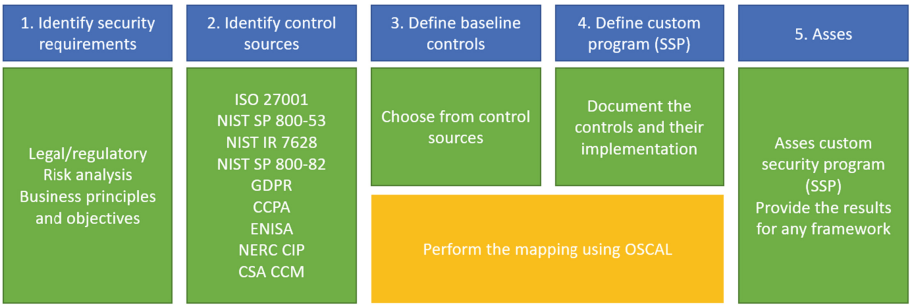

Fig. 2. OSCAL based automated compliance management

The optional (O) and required (X) standards for components represent statistically high probability of applicability as the final confirmation would need to be analysed per each industry 4.0 system and organization.

Besides the baseline security controls, it's important to note that secure software development must be addressed for each component in the following ways:

Table 1. Industry 4.0 security controls catalogue per component

Component/Standard	ISO 27001 NIST 800-53	NIST 800-82	GDPR CCPA	CSA CCM ISO 27017
Cloud/Big data/Cognitive	X		O	X
Machine to M		X	O	
Mobile	O	O	O	O
Advanced robotics		X	O	
IoT	X		O	O
Industry 4.0	**X**	**X**	**X**	**X**

1) If the organization produces software, the use of security development lifecycle (SDL) is required, such as NIST 800-160 [18], or
2) If the organization uses commercial of the shelf products or libraries, supply chain checks need to be performed through supplier cybersecurity evaluation controls, such as specified in ISO 27001 [19], control A.15.

The supply chain evaluation usually focuses on assessing the ISMS and SSP of software vendor. The main reason for having to respond to different framework assessments is having to respond to different customers supply chain checks, usually from different market segments. The central idea of this paper is to rely on OSCAL language and create connections between controls from different frameworks. In this way, assessing custom SSP, defined in step three (Fig. 2), can provide answers to different audits and help maintain compliance within various frameworks. With OSCAL, it is possible to define a set of controls by referencing the controls from other control catalogs (standards). Also, security controls can be enhanced with particular constraints, either by using controls from other standards that are stricter than the controls from the baseline catalog, or by adding explicit customer requirements as constraints to controls. The advantages are that OSCAL is defined in XML, or JSON data format making control description, their enhancements and documentation that addresses particular controls a machine readable, rather than human readable such as traditionally is the case. This reduces the paperwork and enables organization to create security programs that can be assessed more easily by implementing the tools based on OSCAL specification. Table 1 serves as an input for creating a baseline program for industry 4.0 that can be tailored depending on the number of components present in the final system. The process of control mapping can be described with the following activities:

1. Take a baseline catalog. For example, start with NIST SP 800-53 and GDPR,
2. Extend the baseline catalog from catalogs of the frameworks that serve the similar purpose by using OSCAL schemas and constraints that can harden the rules defined by a security control. In this case, controls from NIST SP 800-53 can be extended and mapped to controls from ISO 27001 or ENISA, while GDPR related controls can be mapped to controls extracted from CCPA.

3. The result is a machine-readable security program defined for organization providing software products and/or services. Table 1 represents the baseline security program for industry 4.0.

Once the controls are mapped between different baseline catalogs, the next step is step four: document the controls and reference documentation with OSCAL syntax. Finally, an audit or internal assessment of controls can be done against the custom security program defined by process activities from one to four (Fig. 1). As the controls are mapped against the baseline control catalogue, it is easy using OSCAL to select views of assessment results by querying baseline controls defined in particular standard. Since the mapping between different controls is maintained in XML element references as defined by OSCAL, evidence for one control satisfies all other referenced controls defined in other standards or frameworks.

4 Summary

Organizations that must prove compliance with different standards and regulations usually rely on manual efforts of cybersecurity experts resulting in increased paperwork for maintaining the security compliance management. Different security standards are looking for the same or similar security controls in place to ensure the security of software products or delivered systems and services. In the industry 4.0 era, the challenges arise as the components that comprise systems come in great variety, from cyber-physical assets to the cloud systems.

In brief, the paper enumerates the standards needed in common industry 4.0 components and describes the process for creating custom security program that will enable an organization to provide more effective assessment of security controls through OSCAL. Composing the security program requires time at the beginning, as cybersecurity professionals need to investigate control catalogs of various standards and to perform the mapping. Once the mapping is the complete, OSCAL can be used to store connections between different controls among different standards and to provide references to documented controls. As OSCAL format is machine readable, the process can be automated. Furthermore, the paper gives a baseline of security control catalogs that should comprise an industry 4.0 program with explanations of why industry 4.0 backed by cloud requires the integration of ISMS and SSP. Once the baseline security program is developed, it can easily be shared and re-used among cybersecurity professionals which enables creating a common security controls knowledgebase.

Altogether, it seems that it would be wrong to assume any generic security program can be used as is in any industry 4.0 organization or system. On the contrary, a baseline security program proposed by this research sets the baseline for customization, and, moreover, it can guide the cybersecurity professionals through described process for tailoring the security plan so it meets the needs of different organizations.

Finally, the future research is aimed at publishing OSCAL based baseline programs for industry 4.0 and development of decision support systems that would enable cybersecurity experts to map the controls between the different standards more easily.

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Integration of Value Stream Mapping and Discrete Event Simulation: A Case Study from Lean

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Abstract. The purpose of this paper is to present the practical implementation of value stream mapping (VSM) by monitoring selected key lean parameters and using a discrete event simulation (DES) to generate scenarios for improvement of the process.

The value stream mapping, as one of the basic lean tools, forms the basis for presenting the current state of the system and at the same time opens guidance and opportunities for improvement. The experimentation, i.e. the transition from "as is" to "to be" state of the system is driven by the discrete event simulation, which eliminates the disadvantages of the classic "pencil driven method" and replaces them with the possibilities of the simulation as a tool where it is easy to quantify the change in the system and show the benefit of implementing lean methods. The progress and transit to the future state of the system is monitored through selected key performance indicators. Various experiments have been conducted showing the methodological approach to process improvement.

Keywords: Value stream mapping · Lean · Key performance indicators · Simulation · Guided VSM simulation · Process capacity analysis · Process improvement

1 Introduction

Lean philosophy is treated as a concept that effectively eliminates or at least reduces system losses. Lean with its tools can assist in 8 problems of production planning and control [1], ranging from materials, work and process planning, through the deployment and management of reserves and ending with process design and production and management of the supply chain.

The basic principles of lean defined in [2] are:

- Value
- Value stream

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 201–207, 2022.
http://doi.org/10.1007/978-3-030-97947-8_27

- Flow
- Pull
- Perfection

Lean is defined as the way to specify value in the system, to emphasize actions that add value in the best sequence, to perform these activities without interruption, and to perform them more effectively and efficiently [3]. From this sentence it is worth highlighting a few keywords that will guide you in this paper.

The first part is specifying the value. Using the lean philosophy and its utilities (mainly value stream mapping - VSM) specifying or mapping the value in the considered system will be done.

The second part is the sequencing of activities that add value in the best sequence, in order to optimize the operation of the system under consideration, with the aim of utilizing various lean tools and presenting an appropriate step-by-step methodology for applying these lean tools.

The third and last thing is to carry out these activities without interruption and to increase the effectiveness of their implementation. Monitoring the effectiveness of the system in this paper will be followed by the selection of appropriate lean parameters for which an empirical study of world literature has been made [4].

The lean tool - value stream mapping, will be used as the basis for specifying the value in the system. The authors in [5] state that the implementation of lean manufacturing begins with the creation and development of value stream maps. It is a basic lean tool used to map the current state of the system which, using a series of visual methods and elements, identifies different logistic flows of information and material at multiple levels. The current state map is the basis for identifying losses in the system and the starting point for identifying lean tools for loss reduction [6].

Discrete events simulation (DES) is commonly used in the implementation of lean because they eliminate the weaknesses of VSM. Relevant (compelling) reasons to use them in implementing lean are defined in [7] as follows:

1. The variation must consider randomness and structures.
2. The data must be fully analyzed to allow a better understanding of the random nature of system behavior.
3. Interaction between system components must be evaluated.
4. The future condition must be validated before being applied to minimize or eliminate the trial period, error correction and to reduce risk.
5. Alternatives to the future situation must be systematically identified and considered.

2 Literature Overview

The design and implementation of lean by nature is a deterministic process by nature. Production processes and its elements are variable, although in lean implementation they are defined as deterministic. It is the interaction between the different elements of the process that is one of the main reasons for the introduction of DES during lean implementation [8]. Further in the same paper, lists of ways how a simulation model can improve (enhance) VSM are:

- The time dimension can be included in the model so that dynamic changes in the behavior of the system can be represented and evaluated
- The behaviors of individual entities such as parts, inventory levels, and material handling devices can be observed and inferences regarding behavior made
- Variability, both structural and random, are commonly included in simulation models and the effects of variability on system performance are determined
- The interaction effects between components can be implicitly or explicitly included in a simulation model

Other reasons for introducing simulation as a complementary tool to VSM are its ability to quantify benefits in the early stages of planning and evaluation [6]. Further, in [9] simulation is used to demonstrate its use as a tool to assist organizations in their decision to apply lean, as well as to quantify the benefits of applying lean principles. Some of these benefits are: warehousing and in-process inventory levels; transport and conveyance requirements; the effectiveness of production control and scheduling systems; uniformity of demand and delivery requirements from parts suppliers, and system responsive to market demand and customer delivery requirements.

The disadvantages of the lean approach are also discussed in [7] where lean weaknesses regarding simulation capabilities are presented, possible case studies are presented, and situations when using simulation are presented.

In [10] Lean & DES are used to show a configuration framework which will reflect the impact of the dynamics and complexity of the DES simulation.

The primary role of DES in this paper will be to create a dynamic process of VSM, that is, to establish transit dynamics between the two "as is" and "to be" phases. This role of DES is depicted in [11]. The so-called SimLean approach serves to enable a connection between DES and Lean. Creating dynamic value stream maps is presented in [12], which emphasizes the need to use DES because of the improved capability of analyzing more complex systems compared to traditional VSM maps and for a wider range of products. The capability for detailed analytics of DES is also an advantage versus the "pen and paper" based VSM.

In [13] the need for quantification and optimization of future state maps by using DES simulations as one of the possible methods is emphasized. DES simulation in combination with VSM has been used in [14] to find and answer questions that cannot be addressed with the static model of VSM.

The synthesis of VSM and DES, coupled with appropriate methodology, offers one universal approach that is applicable to almost all industries as well as everyday life. In [15] it is used to analyze the assembly line configuration and efficiency, as well as to present the current forms of losses and their causes. Further in [11], this fusion is demonstrated and the ways they can assist in improving health systems. VSM and DES in [16] are used to evaluate two basic lean strategies, one is pull replenishment and class-based storage policy. Furthermore, the applicability of this synthesis is shown in the process metallurgical industry in [17]. In [18] production planners use the DES model to perform "what if" scenarios to decide where to focus their efforts for continuous improvement.

When analyzing the literature, it is noted that the authors use the VSM and DES methodologies separately. The comparison and value of this paper versus the literature

analyzed is that a unique step-by-step methodology has been developed that incorporates the elements of VSM and Lean in one place and illustrates and quantifies the practical application of lean methods in one process. Performance and transit system from the present to the future state is followed by pre-developed monitoring system in (here referring to KPI labor), which incorporates 5 determinedly indicators of performance. These are VAT (Value Added Time), Cycle time, Lead time, WIP (Work In Process) and Inventory (the last two measured in parts).

3 Integration of VSM and DES

For this purpose, the author will use a real case study from literature [19]. When creating the VSM model, two different methodologies will be synthesized and networked, one for value chain mapping [20] and the other for DES simulation methodology [21].

3.1 Objective of the Paper/Research

In the context of this paper, the need to optimize the situation is expressed through the basic aims of the research:

- Display the transition from the current to the future state of a given process by simulating discrete events
- Develop methodological approach and lean methods for process improvement
- Improve process followed by selected lean key performance indicators
- Lay the groundwork for future research on this topic

3.2 Defining the Problem

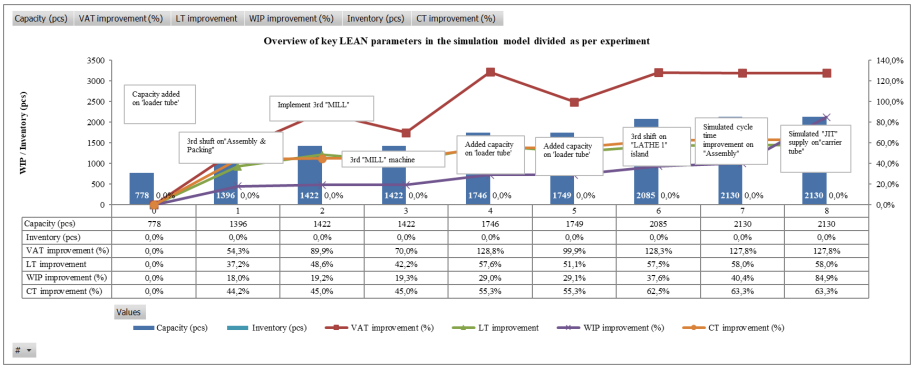
These objectives are the guidelines of the research work conducted (and most of it presented in this paper). The main problem that needs to be undertaken is improvement of the production process based on the Lean principles. It is structured in the following parts:

1. Implementation of the new machine - this step was taken by the authors of the work undertaken and will be a focus for the process improvement,
2. Through picking adequate lean methods and tools, it will be shown how lean can help improve processes.
3. Key performance indicators that are selected within the conducted research and simulated with are:

    a. Value Added Time - time that adds value
    b. Lead time - delivery time
    c. WIP – parts in process
    d. Inventory - stocks (before final delivery, after completion of the entire production process)
    e. Cycle time - a cycle time for a product

3.3 Modeling the Improvements

After numerous simulations, experiment and VSM (that cannot be included in this paper), the final report is shown in Fig. 1, where a sublimation of the results of the LEAN parameters is made which follow the simulation model, i.e. the transition of VSM from the current to the future desired state of the system.



	0	1	2	3	4	5	6	7	8
Capacity (pcs)	778	1396	1422	1422	1746	1749	2085	2130	2130
Inventory (pcs)	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%
VAT improvement (%)	0,0%	54,3%	89,9%	70,0%	128,8%	99,9%	128,3%	127,8%	127,8%
LT improvement	0,0%	37,2%	48,6%	42,2%	57,6%	51,1%	57,5%	58,0%	58,0%
WIP improvement (%)	0,0%	18,0%	19,2%	19,3%	29,0%	29,1%	37,6%	40,4%	84,9%
CT improvement (%)	0,0%	44,2%	45,0%	45,0%	55,3%	55,3%	62,5%	63,3%	63,3%

Fig. 1. Final version of the effect of the phase-separated LEAN parameters

Throughout the experiments in the preceding section, the analyzes were made and the systematic improvements needed to be made to achieve the ideal desired state as suggested by the authors of this paper were given. The improvements in each LEAN parameter are shown in percentages, i.e. the different units of measurement are equalized.

The model was followed through a series of pre-selected LEAN parameters, the results of which are further presented in Table 1. The columns "Notes" and "Lean method" show the process improvements made gradually, while expressing them through the simulation of the corresponding Lean methods.

Following the definition of the given problem and the set scheme, the system capacity was increased by 173% (from 778 to 2130). At the same time, it reflected the LEAN parameters as follows:

- VAT (%) improved from 38,34 to 87,35% or 127,83%;
- Lead time (min) decreased from 45 to 19 min or by 58%;
- WIP (pcs) decreased from 3318 to 502 pieces or 84,9%
- Inventory (pcs) - assumptions and data that were taken as input data did not affect this parameter
- Cycle time (min) improves from 40 to 15 min cycle for single piece production or 63.3%.
- Cycle time (min) improves from 40 to 15 cycles for single piece production or 160%.

Based on these simulation results, a future state VSM was developed.

Table 1. Detailed explanation of the transition and improvements in the experiments

Exp	Sim time (days)	Through-put	VAT (%)	Lead time (min)	WIP	Inventory	Cycle time (min)	Bottleneck	Notes	Lean method
0	22	778	38.34%	45:31	3318	0	1.48	Loader tube supply	Match loader tube supply to assy max capacity	Bottleneck; line balance analysis; Just in Time supply
1	22	1396	59.15%	28:44	2722	0	2.65	Assembly	Add shift to assy & packing	Capacity balance; line utilization
2	22	1422	72.79%	23:30	2680	0	2.69	Mill	ignore 17pcs. Add MILL.	
3	22	1422	65.17%	26:21	2679	0	2.69	Loader tube supply	Match mill capacity	Bottleneck; line balance analysis; Just in Time supply
4	22	1746	87.71%	19:22	2357	0	3.31	Lathe 1	Add shift to fully utilize MILL capacity	Bottleneck; line balance; Capacity utilization analysis
5	22	1749	76.64%	22:15	2352	0	3.31	Loader tube supply	Match mill capacity	Bottleneck; line balance analysis; Just in Time supply
6	22	2085	87.54%	19:25	2070	0	3.95	Assembly	Simulate needed cycle time improvement	KAIZEN
7	22	2130	87.35%	19:03	1978	0	4.03		Optimize Lathe 1 WIP - match lathe capacity	Just in Time supply
8	22	2130	87.35%	19:03	502	0	4.03			

4 Conclusion

The conclusion of this paper will be guided by the objectives set out at the outset in Sect. 3.1.

By modeling and simulating the current situation and following the definition of the problem posed before the start of the simulation, a transition to the future state was made and the same results were conditionally restored within the VSM methodology and an appropriate VSM map of the future state was created.

Throughout the simulation, the impact of several lean methods was modeled and simulated, including “bottleneck analysis”, the JIT method for timely delivery in required quantities and a process-balancing or inter-process method was presented. The methodological approach consists of a synthesis of value chain mapping methodologies and DES methodology and their practical application to a real case.

The results of a series of experiments that were conducted, improving the system using the mentioned lean methods, respectively show an increase in the overall performance of the process. The growth in the state of the selected parameters ranges from 58% to 160%.

The author’s view is that this paper may serve as a basis for simulating, or improving, processes in the future by using and upgrading some of the techniques used in this paper. This approach of using VSM with simulation models is recommended especially at the experiment stage. To this end, this paper provides a solid theoretical basis underpinned by work on a real problem, a work whose settings can be used in practical work on a similar project where mapping the current state of the system via VSM will be done first, and the transition to the future state and the proposed solutions will be underpinned by simulation of the proposed solutions.

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Trust in the Modern Organization: Success Factor in Open Innovation

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Abstract. As a complex and convoluted concept, trust has many dimensions on which it is based, and which are more or less clearly visible. Understanding the process of establishing trust between people and groups implies understanding the various sociological, psychological, cultural and economic relations that determine the structure of trust. Most often in the literature trust is defined through dimensions that are not always clearly identified and that often aggravate the trust measurement problems. This paper analyzes the dimensions of trust, perceived through different theoretical approaches and concepts, but also through the results of a case study research in Serbia. According to conducted research one of the bases for the development of trust is the assessment of the competence of the other party in communication and interaction process. The aim of this paper is to point out the possible benefits obtained by researching the role of trust among employees. The obtained results open numerous questions related to subjective assessments in business communications, the possibilities of their objectification, but also the potential for creating open innovations in organizations.

Keywords: Business communication · Trust · Open innovation · Organizations

1 Introduction

1.1 Theoretical Frameworks and Concepts

Success factors of organizations represent one of the most important and most studied problems of many researchers. Special attention in recent years has been paid to innovative processes.

Previous studies highlight different success factors for the open innovation process: relational aspects, the people involved in the process, governance, facilitators, provision of resources, strategy, process management, leadership and culture [1].

Research on the open innovation process in order to identify critical success factors consists of a systematic on the open innovation process. Chesbrough [2] defines open innovation as the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively. Open innovations defined in this way imply a highly developed human factor and an

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 208–212, 2022.
http://doi.org/10.1007/978-3-030-97947-8_28

enviable level of social capital. In modern approaches to theory and practice, the basis of innovation has equated the importance of internal and external knowledge useful for innovation. With the development of new technologies, the possibilities of sharing knowledge have greatly increased. The flow of information and knowledge is the most important segment of the development of organizational innovation. In the developed world, new methods of innovation development are significantly present. Chesbrough [3] argues that the changing business environment has required organizations to turn from a closed innovation approach to an open one. Dahlander and Gann, [4] however, conclude that a binary classification of open innovation systems and closed ones fails to go into sufficient depth. Instead, the authors argue that the two systems should be viewed as a continuum, making possible varying degrees of innovation systems and thus of openness. McLaughlin [5] believes that open innovation can only be created in conditions of good communication and interpersonal relationships. The problems that organizations face when it comes to open innovation are. West et al. [6] are committed to coordinating efforts to understand human and social capital work towards the development of innovation.

2 Trust in Organizations

2.1 Previous Approaches

Trust is a major problem in creating innovation. One of the reasons for this attitude is the presence of a high level of uncertainty in the innovation process, which makes it difficult to establish trust [7]. Pagden [8] also talks about the paradox related to trust in his analysis. Namely, he believes that trust is necessary in conditions of high uncertainty, and on the other hand, in such conditions, trust is more difficult to establish. Pagden's analysis focuses on the causal relationships between trust, innovation, and the prosperity index. The results showed that trust enables the acceptance of innovations, and the essence of trust is based on non-institutional trust.

In conditions of uncertainty, trust is considered one of the most important preconditions for successful functioning, because it is an essential part of social capital. Social capital can be seen as a set of elements of social structure, both horizontal and vertical connections that affect interpersonal relationships and form the basis for the establishment of general utility [9]. Information potential, which is important for social capital, is at the same time a key starting point in establishing trust in interpersonal relationships.

Trust is defined as the decision of one party to accept the actions of the other party, based on the expectation that the other party will perform a somewhat important, specific and expected action, without the ability to control that work.

Mayer's model of trust development was created through the prism of respecting the characteristics of the one who gives trust, then the one who is given trust and the role of risk in establishing trust in communication. Trust is a function of perception, goodwill, integrity, and a tendency to believe. The model presented by Mayer, Davis and Schurman indicates that three major factors determine organizational trust: the characteristics of the person giving trust, the characteristics of the person being trusted, and the perceived risk. In conditions where both integrity and goodwill are perceived as positive, trust will grow. Mentioned authors also believe that the existence of a tendency to trust, to give and receive trust must include risk, so the difference between the existence of trust and its expression

in behavior refers to the willingness to take risks in communication. While trust implies a willingness to sometimes make oneself vulnerable or weak, according to certain theorists, risk increases this possibility and occurs in behavioral manifestations of trust [10]. The preference of the recipient and the elements of trust possessed by the provider affect the level of trust between the recipient and the provider. The characteristics of the one who receives trust are presented as the inclination of the one who receives trust, in the sense that some individuals are more willing to believe than others. The characteristics of the one who provides trust are represented by its reliability and credibility.

In accordance with Mayer's views and the influential integrative model of trustworthiness, trust is a subjective set of beliefs that relates to other people, and implies the view that the other party has a relationship of trust [10]. Gillespie [11] identifies two dominant categories that determine trust in work contexts: reliance on knowledge, skills, abilities, including delegating and giving autonomy, and openness to sharing sensitive personal information at work, with the other party. The motives and character of the other party, beliefs, predictions or assurance about the probable future behavior of the other party form the basis for helping to generate an initial decision on the other party's reliability based on available evidence, identifying the following dimensions of reliability: ability (skill group, competence and characteristics, which enable the individual to have influence in a particular area), goodwill (perception of the positive orientation of the person giving trust, including the expression of genuine care and protection) and integrity (perception that the person trusted is based on honesty and fairness); the propensity to believe will also influence their decision to trust [12]. The behavioral aspect of trust observation is based on the assumption of the existence of risks in communications in which trust is established. Trust, according to this view, is also a willingness to take risks. The level of trust also depends on the level of perceived risk in a particular situation. If the level of trust exceeds the level of the perceived risk threshold, then the person giving trust will participate in the communication and the risk-taking relationship. If the level of perceived risk is higher than the level of trust, then they will not participate in creating a relationship. The model shows the importance of a context in which there is uncertainty and risk. Trust increases in situations in which a positive outcome occurs after taking a risk in communication. What can all influence trust-based behavior? Mayer and coworkers claim that these are control systems, perception of risk in situations, then power relations, relations in social networks and its implications. It is possible to distinguish four causally related constructs that form the basis of trust: trust, reliability of belief, propensity to believe, and believing behavior.

3 Trust and Open Innovation in Organizations

Why is creating open innovation a problem? One of the reasons is that employees are not sufficiently integrated into the processes, and providing them with more energy than the minimum necessary for work is not a recognized need. In conditions in which mutual relations based on trust will reduce the degree of uncertainty, it is possible to establish relations that would support innovation, and in which success would be an imperative and a goal. Innovative organizations create and implement new ideas and nurture a culture of innovation, which implies a special relationship with people, the bearers of new values.

In a meta-analysis of 132 independent samples, a connection was established between trust and willingness to take risks in performing work, such as performing work tasks. Trust has been shown to be a significant moderator of behavior, so behavioral outcomes change when they are influenced by trust. Subjective reasons for establishing trust are personal experiences, understandings, togetherness, expectations, values, and goals [12].

In conditions of uncertainty, such as the current situation caused by the COVID-19 pandemic, uncertain situations are reflected in the fact that it is not possible, even with a given probability (such as risk conditions) to determine the outcome, its consequences and price. Also, in unstable environmental conditions and unstable markets, the role of open innovation has increased significantly. In the study by Shamah and Elsawaby, which perceived the role of trust in creating open innovation, the results indicated the importance of trust as a key element that should be implemented to increase mutual understanding and enable the flow of information and knowledge between different parties [13].

Sheppard and Sherman model of trust development [14] considers the emergence of trust depending on the specifics of the social context in which communication takes place. Institutional mechanisms in organizations serve to encourage reliable behavior or to reduce opportunities for unreliable behavior. The mechanisms needed to establish trust are partly related to the existence of negative consequences if the behavior changes. The essence is in the concept of community of people who, when they act together, can influence the improvement of their relationship. Developing trust in the organization implies knowledge of key information about the other party, which is actively involved and revealed through communication.

Also, another research in Spain, based on qualitative analysis, has shown that building trust contributes to the innovative performance of local businesses [15]. Open innovation processes are complex and consist of several different phases. The search for innovation opportunities and potentials is a complex organizational process in which all stakeholders participate and in which the outcomes are clearly indicated and presented to stakeholders.

4 Conclusion

Business success in an innovative economy includes a number of indicators of work behavior, organization and management that must act in a harmonized manner and according to a common goal. Innovative processes cannot be established by themselves, they must be an integral part of business policies and procedures in which employees and their intellectual and social capital are directed towards common, well-structured goals and guided in a way that creates mutual trust and conditions for innovative climate in to which innovation is the basis of progress.

New business relations between organizations require the development of human capital, the most important of which are independence, communication and the ability to build and maintain strong relations between employees. Information and communication technology is embedded in a large number of interpersonal interactions and business transactions, and people have become more technologically dependent than ever before. The problem of organizations relates to the ability to predict the future needs of both employees and users of services or products. Such requirements for employees and

organizations include training of both employees and organizations for open innovation. The use of high technologies in the generation of products and services requires permanent investment in equipment, but above all in the development of employees. The key question that arises is how will the business environment function, which would have innovation as an imperative? One of the many answers will surely refer to the role of trust in the open innovation process. The practical implications of scientific knowledge about the influences of the trust process on employee behavior are reflected in the possibilities for improving organizational performance and increasing the predictability of employee work behavior.

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The Power of Media Message in Advertising of Medical Preparations

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Abstract. The presence of topics on health, health system, health policy and public health messages in the mass media has been on the rise. This has been accompanied by an increase in advertising of medical preparations and dietary products. The research conducted on a sample of 150 respondents aimed to determine the trust of research participants in media messages about medical preparations, with special reference to their attitude towards advertising of dietary supplements and their possible intention to buy and use those products, being encouraged by media advertising. The research showed that almost four fifths of respondents in the research were informed about health topics through the media and the same percentage of them was informed through television and social networking sites. Although the majority of respondents did not use the advertised dietary products, research showed that they were well informed about the attractive advertisements of these medical preparations. Furthermore, the participants were divided over their trust in those media advertised products.

Keywords: Media · Health · Advertising · Medical preparations

1 Introduction

Health and the right to health is one of the most important areas of human rights as well as one of the most important issues in the life of every human being. Finding information through the media has become an increasingly common way of obtaining various information about health, health policy, preventive healthcare and treatment. Many health problems are no longer just a matter of the individual or his/her immediate environment, but they have become social issues as well. In addition, the social context can affect health directly or indirectly.

Mass media programs dedicate a significant part of their time to informing about various aspects of health, and they have become important actors in the shaping of the public discourse on health [1]. The mass media have significant technical and human resources to send positive health messages, and they have been using that potential more often and more sophisticatedly. Health promotion through media can be classified as a 'public service' despite its relatively low (cost) effectiveness.

The World Health Organization [2] defines health promotion as the process of enabling people to take control of their own health in order to improve and enhance

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 213–220, 2022.
http://doi.org/10.1007/978-3-030-97947-8_29

it, as well as of the conditions they live in. Health promotion includes: healthy upbringing, education about health, information on health, as well as a set of activities targeted at a group of people or individuals with the aim of establishing a healthier environment in their community, cities, and schools [3].

This paper investigates the consumers' attitudes and opinions on the effects of mass communication in health promotion. The aim was to determine the trust of the research participants in the messages conveyed by media on various medical preparations, especially about their attitude towards the advertising of dietary products and possible intention to use them. Quantitative research was conducted on a sample of 150 respondents.

2 Media Health Promotion

Health communication, as part of communicative practice, includes various strategies of mediating symbolic messages and meanings in the field of medical theory, research and practice [4] of advertising medical services and various preparations. This influences and motivates individual and social decision-making in order to improve physical and mental health, prevent illness, injury and disability. Although there are many other sources of information related to health, radio, television and the press play a significant role in health communication, either in traditional form or through multimedia platforms.

Promotion of health and a healthy lifestyle is achieved by advertising a large number of medicinal and quasi-medicinal products. The intention of media promotion of such products is to persuade both potential and existing customers to make a purchase decision by using a convincing message about the product in the advertisement. However, the law specifies the duration of advertisement as well as the categories of products that can be advertised. Moreover, the promotion of medicines and medical preparations always includes a warning at the end of each advertisement that says: Read the instructions carefully before use. Ask your doctor or pharmacist about the indications, precautions, protection and side effects of the medicine.

According to the *Rulebook on the manner of advertising a medicine or a medical device* [5], some medicines can be advertised, and those are those that are issued without a prescription. Dietary products also fall into this category. Advertisements for over-the-counter drugs should contain clear information that the product being advertised is a medicine, that is, a medical device, its name, brief description, method of application and mandatory warning, while each advertisement also contains an adequate slogan thanks to which it differs from other, similar products. For example, one of the most famous advertisements in the domestic media is the advertisement for cough syrup *Herbiko*. It's slogan – *Healthy as Herbiko!* – is engraved in the memory of every person who hears and sees it.

Moreover, there are certain limitations in the process of media promotion of dietary products. When advertising, the public must not be misled by the impression that such products will compensate for all the shortcomings of poor nutrition or completely improve the functioning of the organism. Dietary supplements are not a substitute for healthy food, which is also indicated by the fact that promotion of extreme diets is not recommended as they can lead to various health problems. Consumption of a certain

medicine does not always result in healing, and therefore the public must not be deceived and convinced in the omnipotence of the advertised medicine. In addition, it is also not allowed to state that a certain medicine or preparation is better than a similar competing product.

Various studies have been devoted to this topic. Television and social networks are the media through which information related to dietary products is most often obtained. This has been confirmed by previous research. Efetović [6], for example, states that the products advertised in a good TV campaign achieved the highest sale depending on the television. Polish researchers Kolano and Dudek [7] have discovered that TV commercials have significant effect on the choice of dietary products to be used (primarily products such as: preparations for strengthening hair, skin, nails). According to Antić [8], the most common source of information about dietary products among younger population is the Internet (40%), and the main reason for using such products is weight loss (37.1%).

The results of the research conducted for the purposes of this paper indicate that the attractive presentation of dietary supplements through advertising media was perceived as a company's desire to achieve a single goal – to make a profit, but it did not abuse the trust of its users. This is also confirmed by Szpringer et al. [9], who discovered that the choice of medical preparations and dietary supplements depended greatly on their advertisements, despite the fact that respondents were aware that the information in advertising messages was not always reliable. According to researchers Schlegel-Zawadzka and Barteczko [10], respondents learned about dietary preparations primarily from conversations with people who have nothing to do with medical science (39.8%), and then through television commercials (36.9%).

Media activity, in addition to its informative role, can also have a misinformative intention. Namely, given that the amount of information is growing at an unprecedented rate, the amount of false and potentially harmful information is also growing. Misinformation, caused either by fake information or misinterpretation of health facts, can have significant consequences such as causing panic, creating dissatisfaction with health policy makers, developing distrust in the media, and casting long-lasting doubt in their credibility.

Thus, in terms of media coverage of health problems, we often encounter tabloid reporting of unverified and uncensored information about "new medical breakthroughs" and "new miracle cure", appropriate treatments for "unusual diseases", promising weight loss products or advertisements for general condition of unclear composition, but with a clear slogan – *Think healthy!*. There are many such and similar examples. The tabloid matrix is organized according to the laws of spectacle and persuasion. Persuasion, as an activity or process in which a communicator tries to provoke a change in the beliefs, attitudes or behaviors of others by conveying a message, is particularly effective in a context where the person we are trying to persuade has some degree of free choice (for example, choosing a doctor or medical institution, a dietary product or other medical preparation). Therefore, the persuasive role of media in the promotion of various dietary preparations and medical supplements is the subject of analysis in this paper.

3 Research

3.1 Research Sample and Methodology

The research sample consisted of 150 respondents from Vojvodina who were randomly selected, of which 69.4% were females and 30.6% were males. Regarding the age of the research participants, the most represented were persons aged 18 to 29 years – 54.1%, then from 30 to 44 years – 24.7%, and between 45 and 60 years – 14.1%. Persons older than 60 years accounted for only 7.1% of the total number of respondents. Among the participants in the research, most were highly educated persons, i.e. those who completed four-year studies (38.8%), followed by those who completed only secondary school (25.9%). 16.5% of research participants completed master studies, and 14.1% completed higher education. Only 4.7% of respondents had a doctorate. More than half of the respondents (54.1%) were employed persons, while 22.4% of them had the status of students or unemployed persons – 16.5%.

This was a quantitative research and the data were collected from surveys. The research was conducted using an electronic questionnaire created in Google Forms. The questionnaire contained a total of 19 questions, divided into four groups, with offered modalities of answers, including socio-demographic characteristics of the research participants (first group of questions). The second group of questions referred to the informing about health through the media, the third to the attitude towards television shows about health, and the fourth to the attitude of the respondents towards dietary products and the way of their media presentation. The research was conducted in the period from December 25, 2019 to January 17, 2020.

3.2 Research Results

Health Information in the Media. As health is one of the most important areas of life, and the quickest way of getting the desired information is through media, it is not surprising that almost four fifths of the research respondents were informed about health topics through media. However, there were some variations regarding the frequency of gaining information in this way: 44.7% of respondents rarely informed themselves about health through media, 32.9% of them were often informed through media, and just 2.4% were regularly informed through media. This way, it can be concluded that 20% of the research participants were not informed about these topics through media.

Research participants who were informed about health topics through the media, most often did so by watching television shows or specialized TV channels – 44.7% or through social networks – 43.5%. Significantly lower percentage of respondents – 21.2% were informed about these topics by reading newspapers and specialized magazines, or by searching specialized websites – 20%. Watching selected *YouTube* channels was a source of information for 18.8%, and blogs and forums for 16.5% of respondents.

Half of the research participants (52.9%) were indeterminate ("neither trusted nor did not trust") when it came to assessing the degree of trust in health information generally placed through the media. Only 1.2% of research participants had complete confidence in the information conveyed in this way. Other respondents only partially believed (22.4%) or had partial distrust (16.5%), while 7.1% of respondents expressed complete distrust.

According to 44.74% of research participants, the expertise of the interlocutors contributed the most to gaining trust in the conveyed health information, while the relevance of the topic (51.32%), approach to the topic and the way of its presentation (50%), as well as knowledge about it whether it is a paid advertisement/sponsorship or not (38.16%), the credibility of the host, if it is a television or radio show (34.21%), and trust in a particular medium through which information is transmitted (32.89%) were assessments that also contributed to gaining confidence in the placed health information.

Healthy diet (71.8%) and topics related to personal health problems or problems of family members of the respondents (61.2%) were the ones that attracted the most attention. Questions in the field of general medicine (49.4%) and fitness (47.1%) were of interest to slightly less than half of the total number of respondents (see Fig. 1).

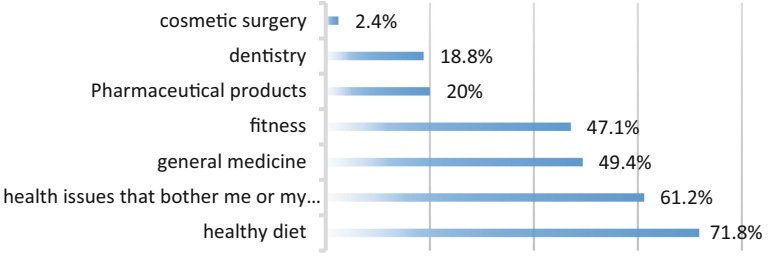

Fig. 1. Respondents' interest in health topics.

Attitude Towards Television Shows About Health. A quarter of the research participants (24.7%) have never watched a show about health, 40% of them have watched those shows occasionally, and 35.3% of them have rarely watched such shows. The most common situations in which the respondents would decide to watch those shows were: topic of the show or guests (55.3%), when a respondent or a member of a family has a health problem that is discussed in the show (44.7%), and in case the respondents want to gain knowledge about the topic discussed in the show (31.8%).

RTS clinic, a show broadcast on the *RTS1* channel, was perceived as a favorite show about health (34.1%), followed by the shows *Healthy with dr Katarina Bajec* on *TV Nova S* (10.6%) and the show *At the right place*, which is broadcast on *TV Prva* (9.4%). However, almost half of the survey participants (45.9%) did not mention any health show as a favorite. Favorite health shows are most often watched in the premiere broadcast period (21.2%), and then delayed, via *YouTube* channels (14.1%), or via social networks (11.8%; see Fig. 2).

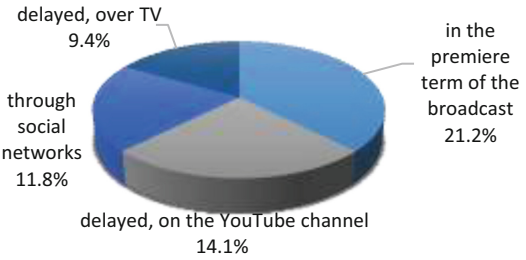

Fig. 2. The way respondents' follow their favorite health show.

Attitude Towards Dietary Products and Their Presence in the Media. The largest number of research participants (69.4%) have never used dietary products. At least one or more such products were used by 18.8% of respondents, and 11.8% of respondents have been in favor of just one product. The respondents who used dietary products were most often informed about them through friends' recommendations (24.7%), TV commercials (17.6%) or through social networking sites (15.3%).

HerbaLife was the most frequently cited dietary product, about which the largest percentage of research participants was informed through the media. This information is not surprising given the fact that the *HerbaLife* company has been advertising heavily and successfully for a few years through all sources of mass communication. In addition to this company, there are other companies that have been advertising many dietary supplements, which is why we found it interesting to learn about general opinion of the research respondents on the advertising of those products.

The largest percentage of respondents completely agreed (32.89%), or only partially agreed (44.74%) with the statement that dietary products are "well marketed with the aim of selling well". However, 55.26% of research participants agreed with the assessment that such products were "were attractively presented to draw the attention, but do not inspire trust".

Indecisiveness was noticeable with those respondents who were of the opinion that dietary supplements were "presented only as information that does not attract attention" (40.79%), then that they will "buy the product if it was recommended by a doctor in the ad" (35.53%), as well as according to the assessment that they are "presented with all the necessary information about the product and are trustworthy" (38.16%).

The research participants disagreed with the statement that "publishing photos before and after product use affects decision on buying the product" (36.84%), or the statement that "advertising further motivates me to buy" and "I believe in advertising and sometimes buy products which are advertised" (38.16%).

In contrast, 46.05% of respondents disagreed completely with the statement "I believe that kilograms are lost after the use of advertised products", and 31.58% of respondents did not agree with it. "If the product is recommended by a public figure I love, I will buy it" was the statement that 39.47% disagreed with, that is, 35.53% of research participants did not agree with this statement, and 36.84% disagreed with the statement "I believe more in those advertisements in which public figures appear" that is, 35.53% of respondents did not agree with it. This information can be valuable

for advertisers because the findings indicate that the inclusion of public figures in the marketing campaign will not contribute to gaining trust in the product itself, regardless of whether the person is respected and loved by the public or not. When it comes to the most frequently advertised dietary products, which are weight loss products, the research showed that the largest percentage of research participants, 72.37%, completely or partially agreed with the statement that "weight loss products are a scam".

4 Conclusion

Respectable media communication theorist Wilbur Schramm [11] warns us that the effects of media messages can be indirect, as a consequence of long-term reference to some form of media persuasion, and direct, as a consequence of a specific message sent to the recipient through media at a moment that the recipient found particularly suitable.

Therefore, the question arises as to how the media message will be received by the audience.

The results of the research showed that there is no complete trust in media advertised medical products (dietary preparations), which is directly related to the factors that affect the acquisition of trust: the content of the message and its presentation, the situation in which the message is received, the personality of the recipient of the message, etc.

At the same time, the media are an important means of informing about various topics in the field of health, primarily about healthy eating and health problems close to respondents or their family members, and statements are made that the amount of such information in Serbian media is insufficient, despite public interest.

In conclusion, research findings can be a good indicator for further scientific research in this area (with a focus on determining the reasons for distrust in advertised media/dietary preparations), as well as for marketing managers, because they indicate the useful insights for future advertising campaign of medical preparations.

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Foreign Direct Investment and Investment Environment: A Systematic Approach

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Abstract. Globalization as phenomenon has intensified the formation of complex adaptive approaches to international business operations, which has resulted in significant organizational activities that include foreign direct investment (FDI), as one of the most important components of contemporary business models. The subject of the research is the analysis of FDI, whose growth can be statistically insignificant or even negative, while FDI in interaction with the growth of investment activities, can have a positive effect on the growth and development of the observed enterprises. The research objective is to determine the performance of FDI with special reference to the situation and opportunities in the investment environment. The research methodology involves the use of the systematic approach and the correlation analyses. The results of the research are significant both to the academic and professional community and indicate that the consequences of the impact of FDI are fuzzy given the dynamic conditions of the investment environment.

Keywords: Foreign direct investment · Investment environment · Systematic approach · Dynamic business conditions · Enterprise

1 Introduction

The question of the significance of foreign direct investment (FDI) arises especially in the period of crisis. International business operations are intensified under the process of globalization and thus induce the structural and organizational changes aimed towards preserving the acquired level of effectiveness and efficiency.

Since the outbreak of the global economic crisis, it is challenging to obtain and maintain the balance between expected and actual investment returns [1]. The process of implementation of reforms is significant for further sustainable growth and development with special accent to the specificities of the developing countries [2].

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 221–226, 2022.
http://doi.org/10.1007/978-3-030-97947-8_30

Making an optimal investment decision is the necessity in the contemporary business conditions [3]. Increase of investment activities is the significant effect of FDI and it is essential for further enterprise growth and development. However, the investment environment determines the existing capacity of both enterprises and broader socio-economic community to exploit the opportunities of attracting FDI. In the dynamic business conditions, which are characterized by extreme events occurrence, it is a special challenge to maintain the obtained level of FDI. Namely, the possibility of making optimal investment decision is severely diminished, which directly affect to the occurrence of defensive investment strategies. Consequently, the negative level of FDI is in most cases immanent.

In the periods of crisis, the enterprises that have had high achieved level of the competitive advantage based on the international business operations, are having difficulties of using both domestic and foreign based resources, particularly while FDI support domestic investment activity [4]. The challenge is even greater if the following is observed: industrial production, Gross Domestic Product (GDP), inflation levels, employment rate, privatization processes, financial markets, etc. Almfraji and Almsafir [5] find a mostly positive causal relationship going from FDI to economic growth.

The motivation of the research is to test the relation between foreign direct investment (FDI) and investment environment with direct or indirect empirical implications. The research results are derived from the author's doctoral thesis [6]. The research is significant both to the academic and professional community and especially to the policy makers in the subject field.

2 Results and Discussion

In order to perform the correlation analyses, the following is observed: number of privatizations, value of Libor, value of Euribor, number of employees and inflation. The analysis was performed on quarterly values. The correlation between FDI in Serbia and LIBOR (or EURIBOR) is significant while determining the overall market investment environment, especially regarding its spillover effect and direct positive effects.

Testing for the stationarity of all variables in the sample is important because finding linear correlations between non-stationary time-series is inappropriate and can lead to spurious results. However, the validity of unit root test becomes very small if the number of observations is small. Hence, small samples do not require unit root testing.

Table 1. Correlation in relation to the number of privatizations, Libor, Euribor (for the euro) number of employees and inflation.

	Privat. No.	Libor	Euribor	Employees	Inflation
Privat. No. Pearson Correlation	1	.519*	.812**	.708**	.057
Sig. (2-tailed)		.019	.000	.000	.810
Value No. N	20	20	20	20	20
Libor Pearson Correlation	.519*	1	.816**	.570**	.073
Sig. (2-tailed)	.019		.000	.009	.758
Value No. N	20	20	20	20	20
Euribor Pearson Correlation	.812**	.816**	1	.758**	.285
Sig. (2-tailed)	.000	.000		.000	.224
Value No. N	20	20	20	20	20
Employees Pearson Correlation	.708**	.570**	.758**	1	.255
Sig. (2-tailed)	.000	.009	.000		.279
Value No. N	20	20	20	20	20
Inflation Pearson Correlation	.057	.073	.285	.255	1
Sig. (2-tailed)	.810	.758	.224	.279	
Value No. N	20	20	20	20	20

*Correlation is significant at the 0.05 level (2-tailed).
**Correlation is significant at the 0.01 level (2-tailed).
Source: the author's calculations [6]

In Table 1 the data comprise the period from 01.01.2007 to 30.06.2011.

Table 2. Correlation in relation to the number of privatizations, Libor, Euribor (for the euro) and number of employees.

	Privat. No.	Libor	Euribor	Employees
Privat. No. Pearson Correlation	1	.498**	.435**	.451**
Sig. (2-tailed)		.002	.009	.007
Value No. N	35	35	35	35
Libor Pearson Correlation	.498**	1	−.043	.318
Sig. (2-tailed)	.002		.808	.063
Value No. N	35	35	35	35
Euribor Pearson Correlation	.435**	−.043	1	.446**
Sig. (2-tailed)	.009	.808		.007
Value No. N	35	35	35	35
Employees Pearson Correlation	.451**	.318	.446**	1
Sig. (2-tailed)	.007	.063	.007	
Value No. N	35	35	35	35

**Correlation is significant at the 0.01 level (2-tailed).
Source: the author's calculations [6]

For the period from 31.12.2002 to 30.06.2011. (Table 2) there were no data on inflation, so the analysis was done without this variable. Hence, a correlation analysis was made between the number of privatizations of Euribor and Libor on a quarterly basis.

The number of privatizations during three months was taken for privatizations. The year is divided into four parts, three months each, and the values of Libor and Euribor are the same expressed on a quarterly basis. Also, the correlation test between the number of privatizations and the change in the value of Euribor and Libor is done on a quarterly basis.

In places where two stars are marked, the correlation is significant, and the number next to Sig. (2-tailed) indicates with what level of significance.

Table 3. Correlation in relation to the number of privatizations, quarterly Euribor and quarterly Libor.

	Privat. No.	Euribor 3m	Libor 3m
Privat. No. Pearson Correlation	1	.498**	.435**
Sig. (2-tailed)		.002	.009
Value No. N	35	35	35
Euribor 3m Pearson Correlation	.498**	1	−.043
Sig. (2-tailed)	.002		.808
Value No. N	35	35	35
Libor 3m Pearson Correlation	.435**	−.043	1
Sig. (2-tailed)	.009	.808	
Value No. N	35	35	35

**Correlation is significant at the 0.01 level (2-tailed).
Source: the author's calculations [6]

The numbers marked underlined (Table 3) show that the correlation exists, it is not strong, but it is calculated. The maximum correlation is 1 and the minimum is 0. It is obtained around 0.435, which means that it is not a strong correlation. There is a similar correlation between the number of privatizations and the ratio of Euribor and Libor. At Euribor it is somewhat stronger, but it is not more significant than it is at Libor.

The overview of total FDI (tested period: 2001–2011, see Fig. 1) by years indicates that in 2001 there were the least FDI, while in 2006 there were the most FDI. Until 2006, FDI was on the rise, while after 2006 it was on the decline.

Figure 1 shows the changes in value by years from 2001 to 2013 for FDI (in millions of Euros), tenders in total, auctions in total and the capital market in total. Based on the given figure, it can be seen that, in the period 2001 to 2004, there was a similar trend in the change of values for the analyzed parameters, while after 2004 the trend of total FDI is different compared to other parameters.

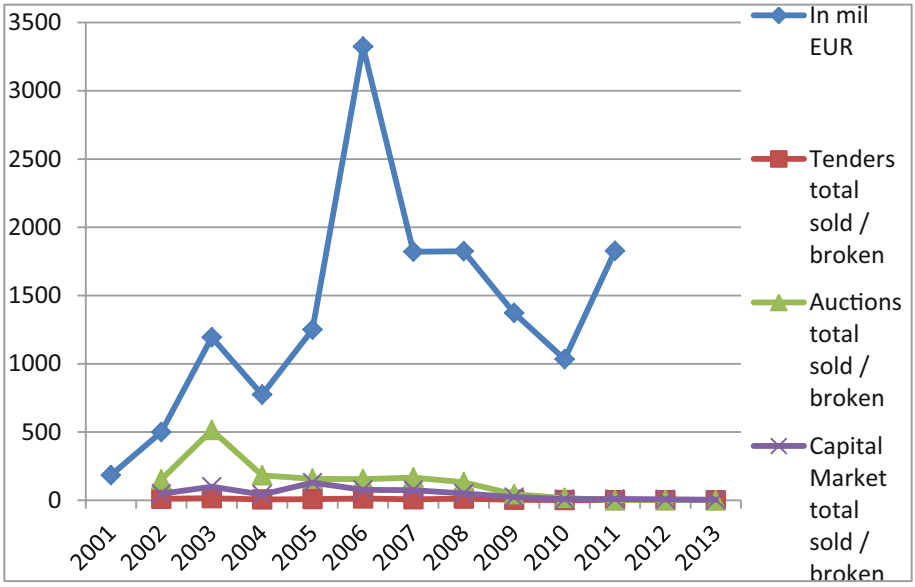

Fig. 1. Comparative overview of Foreign Direct Investment, tenders, auctions and capital markets in the Republic of Serbia. Source: the author's calculations [6]

3 Concluding Remarks

The results of the research point to the necessity of systematic approach to testing foreign direct investment (FDI) and investment environment. Dynamic business conditions significantly affect to the possibility of attracting FDI and the stability of the investment environment. Number of privatizations, value of Libor, value of Euribor, number of employees and inflation were tested and analyzed. Hence, while making an optimal investment decision, various factors must be considered, especially in developing countries.

The results of the FDI analyses confirm its sensibility to the dynamic business conditions, that is, the extreme events occurrence, which is expressed in the decline of total FDI. Also, it is even more significant in the comparison with the performed enterprise privatization processes model, regardless being tenders, auctions or the capital market.

The limits of the research are the lack of consistent historical data in the longer time period, the fact the results could be affected by the "small sample bias" and the lack of previous research studies in the subject field with special attention to the transitional and developing countries.

The future research comprises further testing taking into account the fuzziness of the investment environment and its effects to the investment processes.

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Foreign Direct Investments in Serbian Power Sector: A Discussion on Investments and Impact on Economic Growth

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Abstract. In modern business environment, Serbian energy sector faces a number of challenges that need to be solved in order to ensure the future efficient, effective and sustainable provision of energy services to the population and economy. The power sector is essential for a country's economy because it directs the entire energy sector to a sustainable and cleaner path. Growing pressures for energy security, reducing energy costs and increasing energy efficiency bring many problems and obstacles, and foreign direct investments (FDI) contribute to overcome these problems, especially in the emerging countries, such as Serbia. Currently, Serbian energy sector is in development phase and in the past few years Serbia has passed through strategic documents and laws that open the possibility of faster development of this crucial sector. There is a large number of scientific papers examining the impact of FDI on other economic sectors, but a scarce number of papers examining their impact on the energy sector. Therefore, the aim of this paper is to discuss Serbian case by analyzing the current state of Serbian FDI inflows by sectors and conducting Pearson's multiple bivariate analysis for post crisis period, to study the correlation between selected Serbian power sector variables (energy FDI inflows, electricity consumption and CO2 emissions) and economic growth measured by Gross domestic product (GDP).

Keywords: FDI · Power sector · Economic growth · Pearson correlation

1 Introduction

FDI are considered the most acceptable form of engaging private foreign savings in the process of financing economic growth. Therefore, in modern business conditions, countries, and especially those in development, including the Republic of Serbia, see the key to economic growth in FDIs. Investments are machines of economic growth because, whether they are domestic or foreign investments, they are always the driving force of economic growth of a country.

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 227–235, 2022.
http://doi.org/10.1007/978-3-030-97947-8_31

It is indisputable that the energy sector is of great importance for the entire economy of a country, as well as for the society. It is necessary for the energy sector to be well-organized, modern and efficient, in order to enable the economic progress of a country.

The very nature of the energy sector, which is a very investment-intensive branch of the economy, requires the attraction of foreign investments. Moreover, the overall state of the economy is highly affected by the efficiency of the energy sector [1]. Since increasing energy efficiency usually initially requires large investments, it is necessary to support investments through various incentives and regulations, in order to encourage the introduction of energy efficiency measures [2]. On the other hand, FDI in the energy sector can have a significant impact on human health, environment, safety, as well as on the national sovereignty over natural resources [3]. Thus, it is important to find a balanced national policy.

According to Pareżanin [4], even though there has been a growing trend of FDI in renewable energy sources, investments in the energy sector of The Republic of Serbia remain relatively modest.

Serbian Law on Energy stipulates that renewable energy sources are non-fossil energy sources such as: watercourses, biomass, wind, sun, biogas, landfill gas, gas from sewage treatment plants and geothermal energy sources. The status of a privileged producer entails various incentives, such as the obligatory purchase of electricity (from a privileged producer), regulated purchase prices, balanced liability, etc. [5].

This paper is structured as follows: unit 2 – provides an overview of previous research on the relationship between FDI and economic growth in general, as well as the relationship between FDI and economic growth through the energy sector and the degree of environmental pollution. Unit 3 – gives a short overview of FDI inflows into the Serbian energy sector and the state of the energy sector in general. Unit 4 – deals with data sources, methodology and research results. In the last part of the paper, unit 5, a conclusion is given.

The aim of this paper is to discuss the current state of FDI in the Republic of Serbia by economic sectors with special reference to the energy sector, as well as to analyze the impact of Serbian energy sector variables (energy FDI inflows, electricity consumption and CO2 emissions) on economic growth in the Republic of Serbia using the Pearson correlation coefficient (R) in the post-crisis period.

2 Literature Review

A number of foreign researchers have addressed the issue of the impact of FDI in the energy sector on the economic growth of the receiving country, as well as on environmental pollution.

Khatun and Ahamad [6] could not find the direct causal relationship between energy sector FDI and economic growth, both long-term and short-term, using Granger causality tests in the case of Bangladesh. They revealed in the research that there is strong positive and one-way short-term causality going from FDI to energy use and from energy to GDP growth. However, they stated that, given the given the lack of technological development of the energy sector, FDI should be encouraged in this sector, which is ultimately necessary for economic growth.

Osano and Koine [7] analyzed the role of foreign direct investment in technology transfer and economic growth in Kenya, focusing on the energy sector in Nairobi. The study found that there is a correlation between FDI variables (infrastructure, trade facilitation, knowledge management) and technology transfer and economic growth. Moreover, the study revealed that foreign investments in the energy sector have contributed to the development of new technologies through the transfer of knowledge about new ways of production, development and research. In addition, competition has increased, which has contributed to the efficiency of the industry.

Latief and Lefen [8] researched the causality between the FDI in the power and energy sector, the energy consumption, and the economic growth of Pakistan for the period 1990–2017. The results revealed that there is a positive bi-directional short-run causal relationship between economic growth and energy consumption, concluding that "declining trend in energy consumption could be harmful to economic growth and vice versa". The study also showed that GDP do not have a causal relationship with FDI.

Similarly, Abdullah [9] analyzed the correlation between FDI, electricity consumption and economic growth in India and Pakistan. The research results showed that for Pakistan, FDI and economic growth cause electricity consumption in the long run, that is, causal links go from FDI and economic growth to electric power consumption. In the case of India, a bi-lateral relation between FDI and economic growth was determined, and also a causal link that goes from electricity consumption and economic growth to FDI.

Ibrahiem [10] concluded that both FDI and renewable electricity consumption have a long-term positive effect on economic growth in Egypt. The study confirmed the existence of correlation between economic growth, renewable electricity consumption and foreign direct investment.

When it comes to the debate whether FDI flows result in *pollution havens* or *pollution halos*, opinions are still divided. Environmentalists argue that FDIs have a negative impact on the environment; in contrast to that, neoliberal economists claim that multinational corporations contribute to sustainable development by bringing cleaner and more advanced technology to the host countries. Nestorović [11] states that the example of China can show that FDI in the energy sector have increased energy efficiency and reduced emissions, because they are primarily focused on the production and use of advanced technologies.

Pao and Tsai [12] found in their research that there is a strong two-way causal link between CO2 emissions and FDI in BRIC countries. The research results also showed that energy consumption affects the emissions. These authors concluded that developing countries should take into account the protection of the environment and examine the conditions for foreign investments and in that sense work on the transfer of technology in order to prevent environmental pollution.

3 An Overview of Serbian Energy FDI Inflows and Energy Sector

Serbia is an energy-intensive country – energy is not used efficiently. Today, Serbia is an energy-dependent country but with the potential for full energy independence. Total primary energy consumption in 2010 was 15,531 Mtoe. Serbia's energy-import dependence in 2010 was 33.6%. During 2010, 54% of crude oil, 26% of natural gas and 12% of coal were mostly imported [16]. Energy sector is essential in the development process of Serbian economy and using energy from renewable sources should be the main goal in order to reduce environmental pollution. Renewable energy sector in Serbia is in the establishment process. Utilization of renewable energy sources (RES) is limited to hydropower plants and non-commercial use of biomass and geothermal energy. Hydropower is the only RES utilized for electricity generation and registered in the official Serbian Energy Balance [17].

As shown in Table 1, manufacturing sector received the highest FDI inflows among all sectors, €6727 million, and the increase was relatively stable. Further, high FDI inflows were also recorded in financial services and wholesale & retail sector. In financial services sector significant decrease was recorded in 2013 (€142 million) and 2019 (€156 million) and in wholesale & retail sector from 2011 to 2012 (from €1019 million to €194 million). The sectors with the lowest investment inflows are health & social services, information, energy and real estate sector. In health & social services sector FDI inflows are the lowest. Serbia has low inflows of foreign investments in energy sector (only €205 million in total), with notable increase in 2019 (€84 million).

Table 1. FDI inflows by sector in Serbia, € Million.

Sector/Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total
Manufact.	329	631	521	679	535	721	750	634	930	997	6727
Financ. Serv.	433	840	291	142	358	484	447	368	425	156	3944
Energy	6	3	4	9	10	13	15	52	9	84	205
Wholes./Ret.	133	1019	194	300	225	209	138	312	324	316	3170
Mining	204	478	219	180	26	22	−33	103	415	128	1742
Construction	35	92	19	67	163	265	273	407	472	945	2738
Real estate	−20	72	22	−56	25	58	125	222	161	123	732
Information	−8	126	−480	29	47	108	121	198	−204	202	139
Health/Soc.	0	0.1	0.1	0.1	0.1	−0.1	−0.2	2	0.4	0	2.5
Transp./Stor.	21	66	17	71	−9	69	69	22	654	594	1574

Data source: National bank of Serbia.

With regard to the sector, according to IEA data available, the highest CO2 emissions were made by electricity and heat producers (even 13603 MT CO2 in 2017.), transport (even 8040 MT CO2 in 2017.) and industry (even 6408 MT CO2 in 2017.).

4 Methodology, Data and Results

This paper analyzes the impact of FDI on the economic growth of Serbia in the post-crisis period 2008–2019. All necessary data were taken from the official website of World Bank, International Energy Agency (IEA) and National bank of Serbia. The linear relationship between selected Serbian power sector variables (energy FDI inflows, electricity consumption and CO2 emissions) and economic growth was examined. Pearson's bivariate correlation was used for this purpose.

Energy FDI inflows (ENFDI) are the inflows of FDI to the Serbian power sector. Data were taken from the official website of National bank of Serbia and shows electricity, gas, steam and air conditioning supply in million Euros. Since it's not possible to separate this data into independent sectors, it will be used as a proxy for FDI inflows to the Serbian power sector (Source: National Bank of Serbia).

Electricity consumption (ELCON) measures the production of power plants and combined heat and power plants less transmission, distribution, and transformation losses and own use by heat and power plants (IEA Statistics, 2014). It's expressed per capita and used as a proxy for market potential in Serbian power market.

Carbon dioxide emissions (CO2) means the release of greenhouse gases and/or their precursors into the atmosphere over a specified area and period of time (UN, 1992). CO2 emissions are expressed in metric tones per capita.

Economic growth is expressed as Gross Domestic Product per capita (GDP) and it measures the sum of marketed goods and services produced within the national boundary, averaged across everyone who lives within this territory (OECD, 2014).

Energy FDI inflows, electricity consumption per capita and CO2 emissions per capita were taken as independent variables, and economic growth expressed as GDP per capita was taken as a dependent variable. IBM SPSS Statistics software package was used to calculate Pearson coefficient (R). Before calculating the Pearson coefficient, the ratio of the analyzed variables is represented by the scattering matrix (Fig. 1).

The following Fig. 1 shows the potential bivariate relationships between the analyzed variables. It can be observed that there are probably four positive linear correlations (ENFDI and ELCON, ENFDI and CO2, ENFDI and GDP, ELCON and CO2) and two negative linear correlations (ELCON and GDP, CO2 and GDP) of the observed variables.

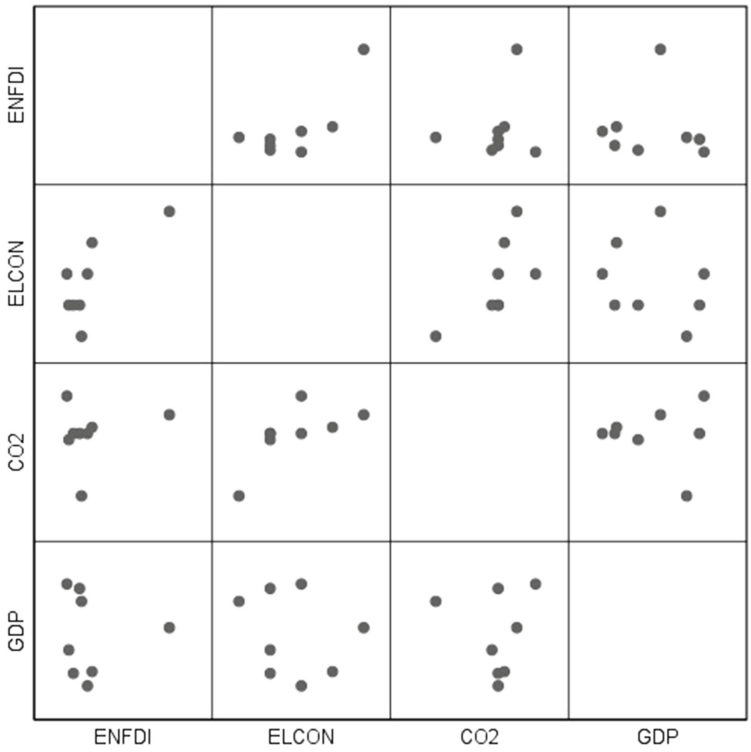

Fig. 1. Relationships between the observed variables (energy FDI inflows, electricity consumption per capita, CO2 emissions per capita and GDP per capita). Source: output of SPSS analysis, author's interpretation.

The next step is to calculate the Pearson coefficient (R). The following Table 2 gives the output result of the performed SPSS data analysis.

Table 2. Correlation between selected Serbian power sector variables and economic growth, in the post-crisis period 2008–2019.

		ENFDI	ELCON	CO2	GDP
ENFDI	Pearson Correlation (R)	1	0.757*	0.195	0.412
	Significance (p)		0.030	0.643	0.236
	Number of years (N)	10	8	8	10
ELCON	Pearson Correlation (R)	0.757*	1	0.355	−0.227
	Significance (p)	0.030		0.314	0.588
	Number of years (N)	8	10	10	8
CO2	Pearson Correlation (R)	0.195	0.355	1	−0.023
	Significance (p)	0.643	0.314		0.957
	Number of years (N)	8	10	10	8
GDP	Pearson Correlation (R)	0.412	−0.227	−0.023	1
	Pearson Correlation (R)	1	0.757*	0.195	0.412
	Significance (p)		0.030	0.643	0.236

*Correlation is significant at the 0.05 level (2-tailed).
Source: output of SPSS analysis, author's interpretation.

Based on the obtained results for the observed period (2008–2019.), it can be concluded that there is a positive correlation between ENFDI and ELCON, due to the positive value of the correlation coefficient ($R = 0.757$). As $0.7 < 0.757 \leq 0.9$ this is a strong correlation. As $p < 0.05$ there is a statistically significant relationship between the observed variables.

There is a positive correlation between ENFDI and CO2, due to the positive value of the correlation coefficient ($R = 0.195$). As $0.195 < 0.3$ this is a very weak correlation. As $p > 0.05$ there is a statistically insignificant relationship between the observed variables. Due to the positive value of the correlation coefficient ($R = 0.412$), there is a positive correlation between ENFDI and GDP, but this correlation is weak since $0.3 < 0.412 < 0.5$. As $p > 0.05$, this relationship is statistically insignificant.

There is a positive correlation between ELCON and CO2 due to the positive value of the correlation coefficient ($R = 0.355$), but this correlation is also weak since $0.3 < 0.355 < 0.5$ and statistically insignificant, since $p > 0.05$.

Further, there is a negative correlation between ELCON and GDP, due to the negative value of the correlation coefficient ($R = -0.227$). As $0.227 < 0.3$ this is a very weak correlation. As $p > 0.05$, this correlation is statistically insignificant.

There is a negative correlation between CO2 and GDP, due to the negative value of the correlation coefficient ($R = -0.023$). As $0.023 < 0.3$ this correlation is very weak and statistically insignificant, since $p > 0.05$.

5 Conclusion

Energy sources play an important role in economic development, especially in developing countries including Republic of Serbia. In general, power sector is essential in directing the energy sector to a sustainable and cleaner path. Therefore, this study aims to examine the relationship between energy FDI inflows, electricity consumption, CO2 emissions and economic growth. For this purpose, Pearson's bivariate correlation was used. The study confirms the presence of positive, strong and statistically significant relationship between energy FDI inflows and electricity consumption per capita. FDI in general causes economic growth, and economic growth causes electricity consumption, so attracting FDI is important for both sources (electricity and economic growth). Also, two more positive correlations were found, correlation between energy FDI inflows and CO2 emissions per capita and GDP per capita, but those correlations are weak and statistically insignificant. Negative weak statistically insignificant correlations were noted between electricity consumption per capita and GDP per capita, and CO2 emissions per capita and GDP per capita. Since economic growth causes electricity consumption, it also causes renewable electricity consumption, therefore the development of renewable electricity sources is of great importance for every country. The efforts onto renewable energy sources would become more visible if domestic companies would improve their behavior in the area of green energy usage. In Serbia and countries in the region there is generally a lack of scientific research in the area of FDI, therefore future researchers are suggested to devote more attention to FDI as well as to the relationship between FDI and economic growth.

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A Model for the Evaluation of the Information Processing Rate of Smart Operators

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Abstract. The evolution of production environments towards Industry 4.0 paradigm led to a workload shift from physical to more cognitive activities, leading operators to perform tasks more cognitive-oriented. According to recent scientific studies, the typology of tasks as well as their complexity in smart factories will significantly change with the increased role of automation and artificial intelligence. Consistently to this trend, in the future work environments, operators will frequently interact with ever-smart machines. Under this perspective, the operators of smart factories, so-called "smart-operators", will manage an increasing amount of information and data during the decision-making processes. In scientific literature many studies are available on the evaluation of the operators' effort for the accomplishment of a physical-oriented task, but clear gaps are present for the evaluation of the operators' capacities and effort involved in cognitive-oriented tasks. In this paper, an analytical model allowing to evaluate, based on the operator's experience and on the complexity of the cognitive-oriented task to be performed, the Information Processing Rate (IPR) of a specific operator is presented. The results of the numerical experiment carried out proved the effectiveness of the model to provide the IPR of the operators by varying their experience and to evaluate if an operator is eligible for the accomplishment of a cognitive-oriented task. A potential application of the model is in the design phase of a cognitive-oriented task to predict the feasibility of its accomplishment by focusing on the capacities of operators.

Keywords: Mental workload · Cognitive-oriented task · Information Processing Rate

1 Introduction

The changes introduced in Industry 4.0 led operators to perform more and more cognitive tasks with negligible motor content, thus underlying the importance and the need for a major focus on the operators' capacities and limits involved in more cognitive-oriented tasks. Focusing on the cognitive-oriented task, any operator could not perform an activity that requires a mental demand that exceeds his mental capacity [1] since every person can be considered as an information processor with a limited capacity [2, 3] and the information processing demand required by the operator must not exceed his capacity to

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 236–244, 2022.
http://doi.org/10.1007/978-3-030-97947-8_32

accomplish the task [4, 5]. The time needed to process a certain amount of information can be reduced with practice and experience [2], so the related information processing ability or Information Processing Rate (IPR) of the subject can be consequently increased.

The ability in performing a cognitive-oriented task with a certain complexity depends on the operator's Information Processing Rate (IPR): the IPR indicates the amount of information that an operator can processes in 1 s, expressed in bit per unit of time (bit/s). The IPR is influenced by the experience and this link is of great interest due to the multiple impacts and implications on human performance such as quality, productivity, and safety, in I4.0 production environments. The model introduced can be usefully adopted to evaluate the IPR required by operators in performing cognitive tasks with negligible motor content with significant potential applications in the I4.0 production systems. The model is applied to a numerical experiment and results obtained proved the importance of evaluating the IPR of operators identifying the most suitable operators' allocation that allows to guarantee the accomplishment of a cognitive-oriented task.

2 State of the Art: The TACOM Measure

The model proposed is based on the TACOM (TAsk COMplexity) measure: TACOM is a measure of the complexity of the execution of a task appeared the first time to measure the complexity of Emergency Operating Procedures in Nuclear Power Plants [6]. The TACOM measure has been evaluated through the 'Shannon Entropy' applied to graphs as each emergency task was described by graph structures. The entropy definition of a graph is still evaluated in bit unit [7]. The evaluation of the entropy of a graph is defined in Eq. 1 [6]:

$$Entropy = H = -\sum_{i=1}^{h} p(A_i) * \log_2 p(A_i) \quad [bit] \tag{1}$$

where A_i is the i^{th} distinctive class in a graph, h is the total number of distinctive classes and $p(A_i)$ the fraction between the number of identical nodes in A_i and the total number of nodes in a graph. In [8] every operator who accomplished an emergency task was timed, so the time needed by the operator to perform it was known (TPT, Task Performance Time) and using a regression analysis, the link between the TPT and the TACOM measure has been obtained. The relation is shown in Eq. 2.

$$TPT = Task\ Performance\ Time = 1,34 * e^{0,987 * TACOM} \quad (s) \tag{2}$$

The emergency tasks had a cognitive nature with a negligible motor content due to the activities that the operators were asked to perform: the work environment simulated an MCR (Main Control Room) composed by conventional control panels [8]. The effort required by the operators in performing the emergency task was mainly a mental effort since activities were mostly of supervision and of decision-making. The experience of the operators is certainly a common feature of the emergency tasks has they had gained up to 14 years of work experience (SRO, Senior Reactor Operator) in MCR operations [9]. Starting from these observations and from the simulations' results, it is possible to model the IPR (Information Processing Rate) for highly experienced operators who perform cognitive-oriented tasks based on the TACOM measure.

3 Material and Methods

3.1 Model for the Evaluation of the Information Processing Rate

The Information Processing Rate (IPR) expresses the amount of information (bit) processed in 1 s and is evaluated in Eq. 3.

$$IPR = \frac{TACOM}{1,34 * e^{0,987 * TACOM}} \quad \left[\frac{bit}{s}\right] \tag{3}$$

Being TACOM $\geq$ 1 bit, as TACOM = 1 bit is the minimum amount of information necessary to choose between two equally likely alternatives (1 bit = $\log_2 2$) [10]. Figure 1 depicts the IPR trend by varying the complexity of the task (TACOM measure).

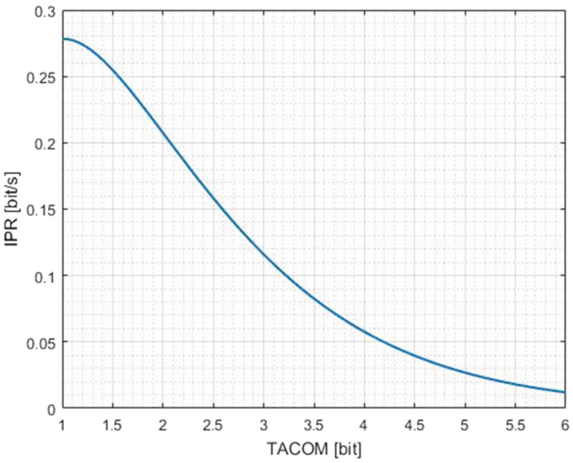

Fig. 1. IPR as a function of the TACOM (TACOM > 1 bit)

The general model for the evaluation of the IPR can be obtained by considering the work experience and modifying Eq. 3.

$$IPR = \frac{TACOM}{TPT} = \frac{TACOM}{k * e^{a * TACOM}} \quad \left[\frac{bit}{s}\right] \tag{4}$$

where a, or k, or both could be considered as a measure of the work experience. It can be demonstrated that parameter a is not representative of the work experience as its slightest variation leads to TPT values to much different (up to ten times) from the ones obtained in [8]. Parameter a is considered a constant equal to 1. Consequently:

$$IPR = \frac{TACOM}{TPT} = \frac{TACOM}{k * e^{TACOM}} \quad \left[\frac{bit}{s}\right] \tag{5}$$

Parameter k can be considered a measure of the work experience as the TPT values obtained with its variation are coherent with TPT values of [8]. The existence domain of parameter k is >0.

3.2 The Feasibility of the Accomplishment of a Cognitive-Oriented Task

The Information Processing Rate (IPR) of the operator defined in Sect. 3.1 allows to evaluate the limit of the capacity of an operator with a given work experience in performing a cognitive-oriented task. The IPR values can be adopted in an analytical model to evaluate the feasibility of the accomplishment of a cognitive-oriented task comparing the complexity of the task to the IPR of the operator. This evaluation starts from the analytical model of Salvendy [11], depicted in Eq. 6.

$$H_{owl} = \frac{TL}{K_e * K_{or}} \leq H_{owl,lim} \quad \left[\frac{bit}{s}\right] \tag{6}$$

The mental workload imposed on the operator (H_{owl} [bit/s]) depends on the Task Load (TL [bit/s]), organizational (K_{or}) and environmental factors (K_e) (both >0 and ≤ 1): these terms represent the objective difficulty in performing a task considering the complexity and the time available to complete the task and the workplace conditions [11]. If K_{or} and K_e are close to one, the operator works in a workplace where the conditions are ideal and allow to minimize the mental workload imposed on the operator (H_{owl}). $H_{owl,lim}$ depends only on the abilities of the operator to process the information to complete the task (decision-making process) considering his resources, such as the level of work experience. To accomplish a task properly, the mental workload imposed on the operator (H_{owl}) must not exceed his mental capacities and resources ($H_{owl,lim}$). The IPR expresses the mental capacities (information processing) and resources (experience) of operator. Hence, Eq. 6 can be modified in Eq. 7.

$$H_{owl} = \frac{TL}{K_e * K_{or}} \leq IPR \quad \left[\frac{bit}{s}\right] \tag{7}$$

A first application of the defined model can be in a resource allocation problem. A task whose complexity (TACOM) and available time (AT) is assigned, is uniquely associated with its TL and considering K_e and K_{or}, it is possible to evaluate the H_{owl} for that task. Consequently, starting from the IPR trends of operators with different experience (k), it is possible to allocate the right operator comparing his IPR value to the H_{owl} calculated. This resource allocation problem has been applied to a numerical experiment in order to test the capability of the model.

4 Numerical Experiment

The model defined in the previous section has been applied to a numerical experiment to prove its effectiveness. The model has been tested on a resource allocation problem. For the simulation it has been assumed a cognitive-oriented task composed by three procedural steps with increasing complexity. Each procedural step has a specific AT (Available Time) and a specific TACOM value. The TACOM measure is composed by five sub-measures, two of which are the SLC (Step Logic Complexity) and SSC (Step Size Complexity), both expressed by the ASG (Action Structure Graph) that represents the number and sequence of actions to be performed. The ASGs for each procedural step are shown in Fig. 2.

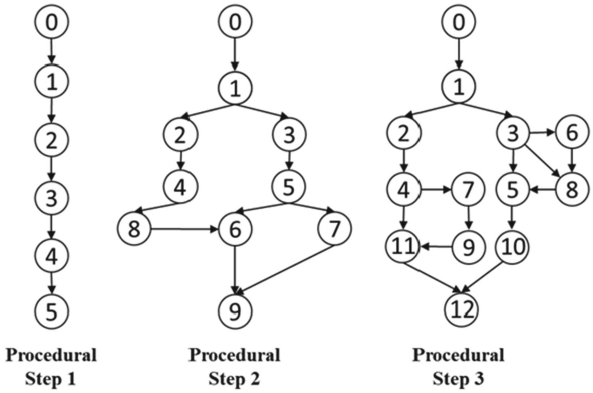

Fig. 2. ASGs procedural steps

From the ASG it is possible to evaluate the entropy (in bit unit) of the SSC and SLC applying Eq. 1 for each procedural step. The other three sub-measures to be evaluated are: SIC (Step Information Complexity), EDC (Engineering Decision Complexity) and AHC (Abstraction Hierarchy Complexity). For the numerical experiment no real task has been analyzed, so to correctly evaluate the TACOM value these three sub-measures have been calculated in relation to the SSC sub-measure as the AHC, EDC and SIC sub-measures are strictly affected by the SSC in a cognitive-oriented task. The correlation between the three sub-measures and SSC has been evaluated through a regression analysis based on the data available in [8]. The results obtained from the regression analysis carried out are shown in Fig. 3.

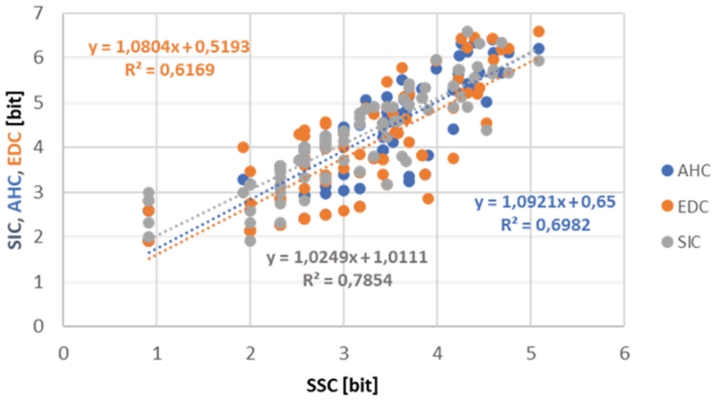

Fig. 3. Linear regression analysis

Applying Eq. 1 and from the results of the regression analysis (Fig. 3), is possible to evaluate the TACOM measure applying its equation (from [12]). Assumed the AT (Available Time) for each procedural step and assuming ideal conditions of the workplace

(k_e and k_{or} equal to 1), it is possible to evaluate the H_{owl} (left-hand member of Eq. 7) for each procedural step. Results are shown in Table 1.

Table 1. Results of TACOM, *TL* and H_{owl}

	SIC (bit)	SLC (bit)	SSC (bit)	AHC (bit)	EDC (bit)	TACOM (bit)	AT (s)	TL (bit/s)	H_{owl}(bit/s)
1	3,660	1,252	2,585	3,473	3,312	3,010	90	0,033	0,033
2	4,414	1,961	3,320	4,276	4,106	3,740	150	0,025	0,025
3	4,803	2,287	3,700	4,691	4,517	4,114	220	0,019	0,019

Each procedural step must be assigned to a specific operator who is characterized by a certain level of work experience. The numerical experiment firstly allows to verify if the operator is eligible to work or not on a specific procedural step, based on his/her IPR value and to find the operator-procedural step allocation that minimizes the total idle time of the cognitive-oriented task (sum of the idle times of the procedural steps). For the resource allocation problem, it has been assumed five operators with different level of experience ($k = 1$, 5-2-2, 5-3-3, 5) whose IPR trends are shown in Fig. 4.

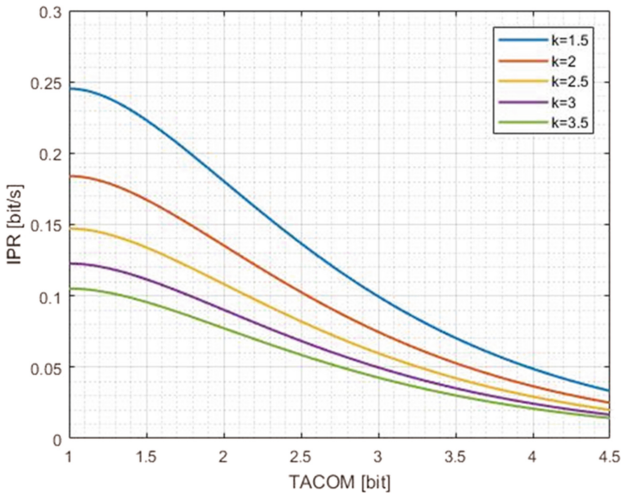

Fig. 4. IPR trends for the five operators

Lower the k parameter, greater the work experience. Knowing the level of experience of an operator (k), is possible to calculate his TPT value depending on the complexity of the task (TACOM) (Eq. 5). From the TACOM values calculated in Table 1, it is possible to evaluate the IPR values and TPT values for each operator (through Eq. 5 and the denominator of Eq. 5 respectively). From Tables 1 and 2 is possible to verify that Eq. 7

is satisfied ($H_{owl} \leq IPR$). The operator-procedural step allocation that minimizes the total idle time of the cognitive-oriented task is determined applying Eq. 8.

$$\min_{\{x_{i,j}\}} \sum_{j=1}^{5} \sum_{i=1}^{3} \left(AT_i - TPT_{i,j}\right) * x_{i,j} \quad [s] \tag{8}$$

Subjected to $AT_i - TPT_{i,j} \geq 0 \;\; \forall i, j$. i = 1, 2, 3 is the ith procedural step, j = 1, …, 5 is the jth operator and $x_{i,j}$ is a boolean variable of the assignment problem ($x_{i,j} = 1$ if the jth operator is assigned to the ith procedural step; $x_{i,j} = 0$ otherwise).

Table 2. IPR and TPT values

Operator	k	IPR values [bit/s]			TPT values [s]		
		1	2	3	1	2	3
A (1)	**1,5**	0,099	0,059	0,045	30,419	63,112	91,781
B (2)	**2**	0,074	0,044	0,034	40,558	84,149	122,375
C (3)	**2,5**	0,059	0,036	0,027	50,698	105,187	152,968
D (4)	**3**	0,049	0,030	0,022	60,837	126,224	183,562
E (5)	**3,5**	0,042	0,025	0,019	70,977	147,261	214,156

Table 3. Operator-procedural step allocation

	Operator-procedural step allocation			Minimum idle time (s)
	1	2	3	
k_e and $k_{or} = 1$	C	D	E	69,022
k_e and $k_{or} = 0{,}9$	E	B	C	151,906

The resource allocation problem has been solved also assuming non-ideal workplace conditions (k_e and k_{or} equal to 0,9). As a consequence, the values of H_{owl} in Table 1 changed (0,041 bit/s for procedural step 1, 0,031 bit/s for procedural step 2, 0,023 bit/s for procedural step 3). Comparing these H_{owl} values with the IPR values in Table 2, the allocation of operator D and E on two procedural steps (2 and 3) does not verify Eq. 7, and for this reason are rejected from that allocations. The operator-procedural step allocation that minimizes the total idle time of the cognitive-oriented task for the two cases are evaluated from Eq. 7 and shown in Table 3. Results of the numerical experiment proved the effectiveness of the model: when $H_{owl} \leq IPR$ is verified for an operator, he/she is able to accomplish the task. In the numerical experiment it has been underlined how the conditions of the workplace affect the H_{owl}: the H_{owl} values calculated in case of k_e and k_{or} equal to 0,9 decreased the number of allowable operator-procedural step allocations as $H_{owl} \leq IPR$ was not satisfied for all the allocation permutations. The allocation of operators D and E in two of the three procedural steps (2 and 3) did not satisfy Eq. 7,

decreasing the number of eligible assignments of the 70% (42 permutations out of 60 have been rejected). The worsening of workplace conditions (from ideal to k_e and k_{or} = 0,9) caused an increase of H_{owl} higher than the 20% for all the procedural steps (comparing the H_{owl} values of the first case to the H_{owl} values of the second case) and the rejection of the 70% of the eligible assignments. Results obtained from the numerical experiment showed potentials of the model in identifying the proper operators' allocation that allow to guarantee the accomplishment of the task. This is guaranteed if the mental workload imposed on the operator (H_{owl}) is lower than his/her mental workload threshold (IPR). The numerical experiment underlined how the model can be applied in industrial context to evaluate the feasibility of the correct execution of a cognitive-oriented task on the base of operators with a certain work experience k ($H_{owl} \leq IPR$), or to identify the most suitable operators for achieving a goal (i.e. minimization of the idle time).

5 Conclusions

The results of this study indicate that the model developed can be adopted to evaluate the feasibility of the accomplishment of a cognitive-oriented task comparing the human capacities to the complexity of the task to be performed verifying that the information processing demand imposed on the operator does not exceed his capacity of accomplishment. The model showed how the level of the work experience matured (k), affects the human capacities (IPR) in performing a task. Results obtained from the numerical experiment showed that the model can be applied in 'smart factories' industrial context in which the operator is asked to perform more and more a cognitive task with negligible motor content, to interact with cyber-physical production system (CPPS) becoming 'smart operator'. If a factory needs to ensure that a certain task must be correctly executed, the numerical experiment showed how not all the operators are eligible. The model can be used as a part of design phase of a cognitive-oriented task described by a procedure to predict the feasibility of its accomplishment focusing on the capacities that an operator need to execute correctly the task (IPR and experience). Future research would be required to validate this model in a real industrial context.

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Impact of Coronavirus COVID-19 Crisis on Insurance Industry of Serbia

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Abstract. Coronavirus - COVID-19 pandemic had a huge impact on companies and business worldwide in 2020. Insurance industry is no different. They faced many unpredictable and demanding situations that require adaptation through the changes in company business, human resources, employment and management. The main aim of our research is to collect, analyze and compare data about these areas which suffered during the coronavirus pandemic period. In this paper, some insurance companies that have offices in Serbia, are used to collect data. As a result of research, we will have insight into managerial moves that they made to handle this crisis on the best possible way, how big impact coronavirus crisis had on their business and is there something that they learned from this crisis that they can use to improve their business and to grow in the future.

Keywords: Coronavirus impact on insurance industry · Coronavirus COVID-19 pandemic crisis · Insurance industry analysis during coronavirus · Insurance industry of Serbia

1 Introduction

In January 2020 the World Health Organization (WHO) declared the outbreak of a new coronavirus disease, COVID-19, to be a Public Health Emergency of International Concern. WHO stated that there is a high risk of COVID-19 spreading to other countries around the world. In March 2020, WHO made the assessment that COVID-19 can be characterized as a pandemic [1]. First registered case in Serbia was on March 6, 2020. State of emergency was announced by Serbian Government on March 15, 2020. with safety measures including limited movement in public. Also, State border was closed [2]. Broadly speaking, the COVID-19 virus is sweeping westwards across the world - beginning in China at the end of 2019. reaching Europe from February/March 2020. and during summer 2020. taking increasing hold in North America, Brazil and India [3, 4].

Insurance companies are by nature of their work dealing with insuring others against their risks, while being exposed to certain risks themselves, the same as other organizations [5]. Insurance industry, like any other, is going through difficult period full of challenges with importance of successful management in order to overcome the crisis.

This research that we conducted in Serbia on a sample of insurance companies, is a step towards a better understanding of existing situation of insurance sector in Serbia, how they are handling the crisis and what can we expect from them in the future.

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 245–252, 2022.
http://doi.org/10.1007/978-3-030-97947-8_33

2 Background and Literature Review

2.1 Global Insurance Industry Loss Predictions and Implications

Lloyd's of London, the world's biggest insurance market, expects to pay out between $3bn and $4.3bn to its customers due to the coronavirus pandemic, as it warned of a $203bn hit for the entire industry. Insurance companies around the world have suffered losses as widespread government shutdowns have prompted claims for business closures, and halted travel and events. The scale of payouts to customers forecast by Lloyd's this year are equivalent to other big claims years for insurers, such as the aftermath of 9/11, when Lloyd's paid out $4.7bn, and in 2017, when hurricanes Harvey, Irma and Maria caused widespread damage and loss, leading to $4.8bn in payouts. The insurance market estimates the industry will face underwriting losses this year of approximately $107bn due to Covid-19. In addition, insurers have seen a slump in the value of their investments which they use to pay claims, of about $96bn, creating a total loss for the industry of over $200bn [6]. According to Lloyd's of London chief executive, John Neal: "What makes Covid-19 unique is the not just the devastating continuing human and social impact, but also the economic shock. All those factors together will challenge the industry as never before, but we will keep focused on supporting our customers and continuing to pay claims over the weeks and months ahead" [6]. In Republic of Serbia, insurance companies are usually large companies [7]. The National Bank of Serbia, as a supervisor in the insurance business, sent a recommendation to all insurance companies operating on the territory of Serbia to enable insurance policyholders to defer payment of due insurance premiums on the basis of insurance contracts which provide for periodic premium payments. This recommendation applies in particular to policyholders who have been banned from moving throughout the day in old age, as well as to those policyholders who have lost their regular income or whose regular income has been significantly reduced so that they are no longer able during the state of emergency to settle its obligations under the insurance contract [8].

During the COVID-19 pandemic, many companies switched to work from home and such a change provided new opportunities for cybercriminals to enter corporate systems and access business data, counting on the curiosity of individuals who are offered "miracle" drugs against viruses or deficient medical devices. This happens to a greater or lesser extent all the time. Cybersecurity risk refers to the probability or possibility that a potentially harmful event will result from deficient cybersecurity [9, 10]. By opening infected links or attachments, access to the company's data is enabled, thefts, misuse or alteration of data. With the increase of such attacks, the development of the cyber insurance market began, so many companies began to look for a solution in from of insurance that would protect them from such attacks. Companies are at a crossroads [11, 12]. According to Sanja Jovanovic, the director of the Corporate Insurance Department in Wiener Städtische, it is predicted that the cyber risk insurance market will grow up to $20 billion in the next five years [13].

How Insurance Companies Have Responded and Adapted to the New COVID-19 Way of Life? COVID-19 will have a severe and immediate impact on the scope and scale of claims, policy wordings, top-line growth, insurers' capital bases and their

investment returns. To respond, insurers will need to move rapidly to a digital operating model, build in flexibility and agility, and find ways to maximize new income [14]. The insurance industry and governments both have important roles to play in facilitating this economic reboot. Governments can provide clear guidelines on how to reduce the spread of COVID-19 and in some areas, work with the insurance industry to provide the security needed in the short term, ahead of a longer term solution. The global insurance industry must respond urgently to customers' changing needs. If it doesn't it risks losing customers who could seek to establish or increase their use of self-insurance through captives, or not buy cover at all [15].

3 Past Research and Their Results

Wells Media Group conducted the Insurance Industry Coronavirus Survey online from May 26 through June 12, 2020. A total of 1,704 respondents participated. They work for insurers, reinsurers, brokerages and vendors to the industry [16]. From Wells Media's Group survey results, we can see that 60% of employees in insurance industry, have worked from home full-time during the pandemic. At the other side, 15% of employees in this industry have worked like before, spending whole time in the office. The rest of 25% of respondents combined working in office and working from home during the COVID-19 pandemic [16]. According to Wells Media Group's study, in insurance industry, company's priorities post-crisis mainly will be: accelerating technology application (62% of all respondents), re-establishing corporate culture (46%), improving cybersecurity (39%) and new product offering (19%), while lesser focus will be on: underwriting changes (12%), fraud prevention (11%), reconfiguring supply chain (7%) and improving employee's benefits (6%) [16].

4 Sample and Methods

This research was conducted in Serbia on a sample of 5 insurance companies (of 16 in total), what makes 31% of all insurance companies located in Serbia. Questions in survey were in form of Likert type of psychometric scale, with a range from 1 to 10, except one question with offered answers. Whole survey contained customized questions and statements that are made by authors of this research.

5 Results

From a survey that is conducted as a part of this research, responses on 5 statements stand out and responses on 1 question as well. On a statement: "The impact of the COVID-19 pandemic on our insurance company is big", insurance companies' responses suggest that impact of coronavirus pandemic on Serbian insurance companies is moderate without extreme high or extreme low impact on companies that participated in this research (Fig. 1).

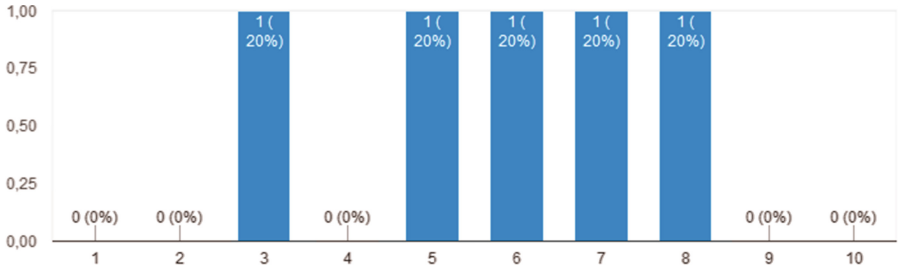

Fig. 1. Responses on statement: "The impact of the COVID-19 pandemic on our insurance company is big"

Second statement of this research is: "During the COVID-19 pandemic, our insurance company operated in the same way as before the epidemic, without any changes in business, management or organization". Responses clearly suggest that most insurance companies in Serbia that were part of this research, suffered really big changes in business, management or organization as a need to handle the crisis. Only one of 5 insurance companies declare that they suffered just smaller changes during the pandemic period (Fig. 2).

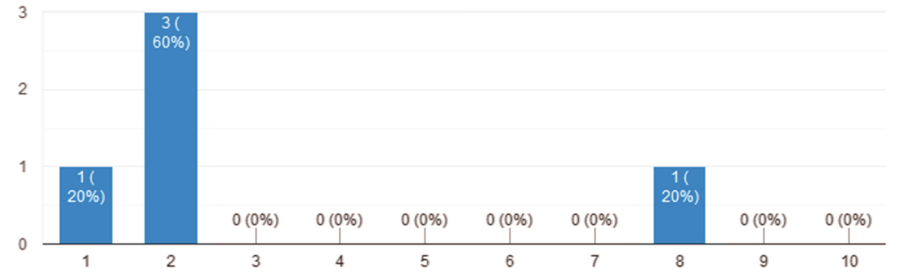

Fig. 2. Responses on statement: "During the COVID-19 pandemic, our insurance company operated in the same way as before the epidemic, without any changes in business, management or organization"

Analyzing responses on third statement: "Employees of our insurance company were enabled to work from home during the COVID-19 pandemic", it comes to the conclusion that most insurance companies (3 of 5) that participated in this survey, fully allowed their employees to have an option to work from home. At the other side, one of these five respondents indicated that majority of their employees didn't have an opportunity to work from home, while one insurance company declared that their employees combine a time that they spend in office and as working from home (Fig. 3).

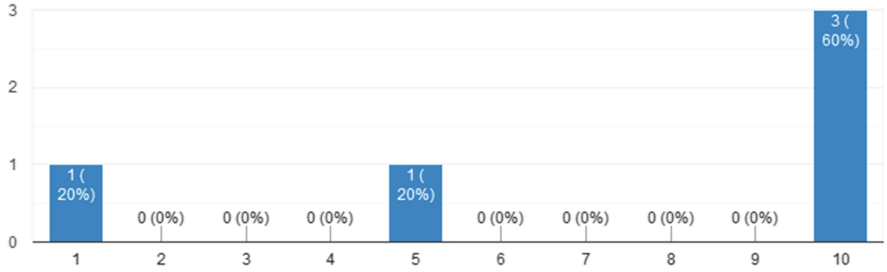

Fig. 3. Responses on statement: "Employees of our insurance company were enabled to work from home during the COVID-19 pandemic"

All insurance companies in Serbia, that took a part in this research, agree about the following statement: "The efficiency of our employees when working from home is lower, compared to the performance that they achieve while working in the office". They all agree that efficiency of their employees that worked from home wasn't significantly lower than when they work in office (Fig. 4).

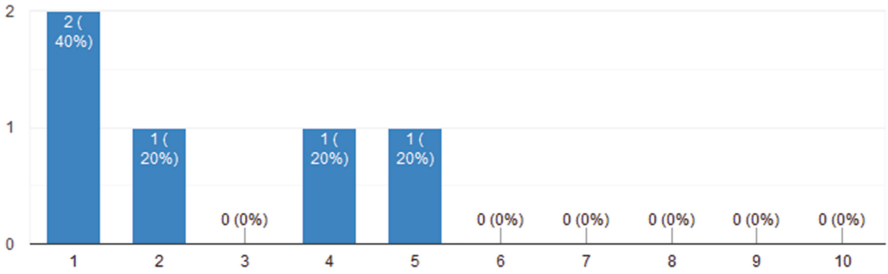

Fig. 4. Responses on statement: "The efficiency of our employees when working from home is lower, compared to the performance that they achieve while working in the office"

Very clear and unambiguous conclusion can be made from last statement. Four out of five insurance companies, on a statement: "During and after the COVID-19 pandemic, we plan to increase the level of digitization when interacting and doing business with our clients", declared that they fully agree (10 out of 10 on Likert type of scale), that increasing level of digitalization when interacting and doing business with clients will be one of their main goals during and after the coronavirus COVID-19 pandemic (Fig. 5).

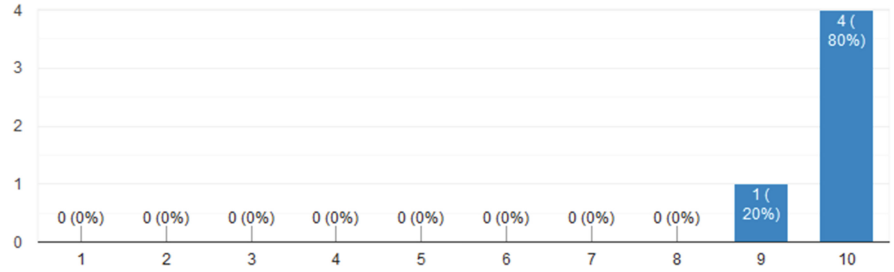

Fig. 5. Responses on statement: "During and after the COVID-19 pandemic, we plan to increase the level of digitization when interacting and doing business with our clients"

Near those statements, five insurance companies in Serbia, that took a part in this research, were asked to mark what will be their company's priorities after the end of the COVID-19 pandemic. Responses on this question are very interesting as all five companies fully agreed about three points as priorities after the COVID-19 crisis: Accelerating technology application, new product offering and underwriting changes. Other points like: Improving cybersecurity, fraud prevention, re-establishing corporate culture and improving employee's benefits got much smaller importance as post-crisis actions (Fig. 6).

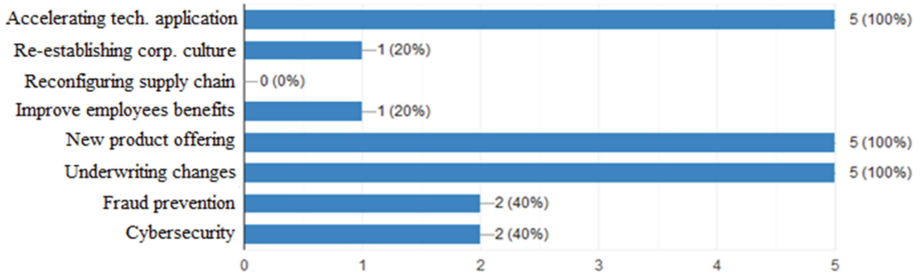

Fig. 6. Responses on statement: "Which of the following points will be your company's priorities after the end of the COVID-19 pandemic? (You can mark more responses offered)"

6 Discussion

In comparison with research of Wells Media Group [16], where they got as a result that 60% of employees in insurance industry have worked from home full-time during the pandemic, 15% have worked like before, spending whole time in the office, while the rest of 25% of respondents combined working in office and working from home during the COVID-19 pandemic, results of our research are very similar. Based on survey of five insurance companies located in Serbia that participated in this research, results show that 60% (3 of 5) companies fully offered an option to their employees to work from home all the time, 20% companies (1 of 5) didn't give a possibility to their employees to

work from home, while 20% (1 of 5) companies allowed their employees to work from home some time while spending the rest of the time in office.

As a survey result on a statement: "Which of the following points will be your company's priorities after the end of the COVID-19 pandemic", Wells Media Group's got that post-crisis priorities mainly will be: accelerating technology application (62% of all respondents), re-establishing corporate culture (46%), improving cybersecurity (39%) and new product offering (19%), while other points got lesser focus [16]. Results of our research suggest that all five insurance companies located in Serbia, that took a part in research, completely agree that accelerating technology application, new product offering and underwriting changes will be their main priorities in post-crisis period. In comparison to Wells Media Group's results, companies from our research did not fully recognize establishing corporate culture and improving cybersecurity as very important topics after the coronavirus COVID-19 pandemic.

7 Conclusion, Deficiency and Directions of Further Research

It is very complex subject how insurance companies will react in post pandemic period. To answer all challenges that Serbian insurance companies face, it is necessary to make significant changes in management and organization. Results of this research clearly indicates that insurance companies will set accelerating digitalization application as a priority. Modern world relies more and more on technology and it is no different in insurance industry. Considering work from home as a new normal, implementing and upgrading technology usage, underwriting changes and offering new products that will satisfy customer's needs will be very actual topics in post pandemic life.

As deficiency we can mention the size of sample, even 5 of 16 is 31% of all insurance companies in Serbia. It would be useful for further research to conduct this analysis on larger sample with adding some other questions and variables that could be helpful for better understanding of this topic.

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Bank Controlling in Montenegro: Effects of the Pandemic Crisis on the Montenegrin Economy, Banking Sector and the Profitability of Banks

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Abstract. Factors such as the expanding rate of globalization and growing bank competition have necessitated cutting net interest margins. Although the importance of controlling in banking business is becoming more recognized, there are still some common misconceptions regarding its exact purpose and implementation. Controlling function in the biggest banks in Montenegro is placed under the department of Finance (third level in the organizational hierarchy). The controllers within the banks are not fully involved in making major decisions. An effective controlling function is becoming even more critical now when the financial performance of the Montenegrin banks has been affected by the COVID 19 pandemic. The effect of the pandemic on the banks in Montenegro has been two-fold. On the one hand, it has led to an increased uncertainty and volatility in the banking market, and on the other to the increased demand for controlling and frequent use of forecast models. Since the effects of the global pandemic could not be anticipated, previously prepared budgets are no longer operational.

The goal of this study is to determine the effects of the changes in the economic activity at the sector and macroeconomic level on the profitability of banks, measured by banks' return on equity (ROE) and return of assets (ROA). The study includes several bank-specific indicators such as: total assets (TA) and credit risk (CR). Also included are macro-economic indicators such as: gross domestic product (GDP) and interest rates (INT). The study used a regression model and included 15 banks in Montenegro.

Keywords: Bank controlling · COVID 19 · ROE · ROA · GDP · Forecast

1 Introduction

Montenegro, as a small country of about 620.000 people, is an open economy and is sensitive to external influences. Modern banks operate in an increasingly complex business environment. The primary reasons for the introduction of controlling in banks are the growing competition in banking and the complex conditions in the internal and external business environment.

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 253–260, 2022.
http://doi.org/10.1007/978-3-030-97947-8_34

Due to strong competition, interest margins are getting thinner by the year and decision making is becoming more complex. More than ever, bank managers are under pressure to make effective and timely decisions, in order to quickly adapt to the rapidly changing business landscape and secure the bank's position on the market. Gaining a competitive edge in such conditions is not possible without a strong controlling function. Bank controlling is aimed at increasing the bank's profitability, expanding its customer base, growing its market share etc. The crisis caused by the COVID 19 pandemic has led to an increased demand for bank controlling and frequent budgeting and forecasting. It becomes difficult for banks to predict the flow of loans, non-performing loans (NPL), deposit portfolio, interest rates, fees, loan portfolio and liquidity risks etc.

The hypothesis tested in this paper is:

H1: Total Assets, Credit Risk, Gross Domestic Product, and Interest rate have a significant impact on banks' Return on Equity and Return of Assets.

2 Literature Review

Controlling is a relatively young scientific discipline that first emerged about 50 years ago. The primary purpose of controlling is assisting management in the decision-making process and increasing the capabilities of the bank to effectively respond to the changes in the market environment. [1] defined a controller as "a person with an extensive experience in accounting". According to these authors, a controller is a pilot who helps the captain safely maneuver the boat into the harbor. Likewise, a business controller must ensure that the company reaches the land of profit. The authors differentiate three stages in the evolution of controlling: They refer to the first stage as "record-keeping". This form of controlling was implemented in the 1950's and 1960's. Controlling was past-oriented in that period and was mainly concerned with the precise recording of business activities. The next stage is called "Navigation". Due to the increasingly volatile business environment, the controlling function evolved beyond just record-keeping, now incorporating tasks such as profit-margin calculation and budget preparation and control. In the third stage, named "Innovation", the controller introduces new instruments and innovations in the business practices, seeking to adapt them more rapidly to the changing environment.

The impact of both bank-specific and macro-economic factors on bank profitability has been widely studied. [2] studied determinants of bank profitability on a sample of 389 banks. According to their study, low inflation and stable economic growth have an effect on credit expansion and profitability. [3] investigated the impact of macroeconomic and bank specific factors on the profitability of the UK's commercial banks. They found that changes in GDP affect the profitability of banks. [4] analyzed the effect of macroeconomic factors, such as GDP and interest rate, on the profitability of banks. [5] investigated the impact of macroeconomic factors on the profitability of commercial banks in Pakistan in the period 2001–2011. They conducted an empirical study which showed a strong positive correlation between interest rates and profitability. GDP had a marginal positive effect on ROA while the inflation rate and profitability correlated negatively. Using a dataset of 154 banks for the period between 1980–2006, [6] found that interest rate, inflation, exchange rate and monetary policy all had a significant effect on bank profitability. [7] examined commercial banks in Nigeria. They found the gross

domestic product to be positively correlated and interest and inflation rates negatively correlated to ROE. [8] used panel data of 21 public sector organizations and 39 banks in India. They investigated the impact of GDP, inflation, exchange rates, money supply and gross domestic savings on bank profitability. Empirical data collected by [9] provide an overview of profitability in the banking sector, prior and following the financial crisis of 2008. The data of 73 UK commercial banks showed that bank size, capital ratio, loans, deposits, liquidity and interest rate positively correlated with ROA and ROE. The data also demonstrated that GDP and inflation rates were negatively correlated with these indicators. Examining both aggregate and individual datasets, [10] found that pro-cyclicality of bank profits is stronger during the periods of deep recessions than during the less severe economic downturns. For each percent of GDP contraction during recession periods, bank assets decreased by 0.24%. [11] found that both bank-specific indicators (asset size, deposits to assets, credit risk) and macroeconomic variables (interest rate) strongly correlate with ROE. They also found that credit risk and interest rate levels have a strong impact on ROA.

3 Data Source and Methodology

The data collected for the purposes of this study mainly come from interviews and official websites of commercial banks in Montenegro. The quantitative analysis offered in the study is based on a dataset provided by the Central Bank of Montenegro [12] and the Statistical Office of Montenegro [13]. The set contains bank-specific, macroeconomic and profitability data for the period between January 2006 to December 2019. The dataset contains 168 figures for each of the selected variables recorded in the given time. The bank-specific indicators include a bank's size (measured by total assets) and credit-risk (measured by the Loan impairment to Gross Loans ratio). The macro-economic indicators include Gross Domestic Product and Interest rate. Return on Equity and Return on Assets are used as profitability measures. The variables are defined as follows:

- *Return of equity (ROE):* Net profit after tax divided by average shareholders' equity.
- *Return of assets (ROA):* Net profit after tax divided by average total assets.
- *Total assets (TA):* Bank's total on-balance-sheet assets.
- *Credit Risk (CR):* Impairment of loans divided by Total assets.
- *Gross domestic product (GDP):* GDP is defined as the growth of economic activity adjusted by inflation.
- *Interest rates (INT):* Weighted average effective interest rate on deposits.

Achieving the stated goals of this study required building predictive models for ROE and ROA. The same set of independent variables was used in both models. Table 1 below gives the summary of the variables used in this study.

The study sought to build $ROE = f(TA, CR, GDP, INT)$ and $ROA = f(TA, CR, GDP, INT)$ models. Pearson's correlation coefficient is a common statistical measure of the strength of a linear association between two variables. The coefficient takes values in the range $[-1, 1]$. Positive values of the coefficient denote positive linear correlation, which means that with the increase of one variable, the other variable increases as well.

Table 1. Variables used in the study

Type	Variables	Notation	Indicators
Independent	Total assets	TA	Bank-specific indicators
	Impairment to Gross loans	CR	
	Gross domestic product	GDP	Macro-economic indicators
	Weighted average effective interest rate on deposits	INT	
Dependent	Return on equity	ROE	Profitability
	Return on assets	ROE	

Conversely, negative values indicate that with the increase of one variable, the other variable decreases. The following categorization was applied to indicate the strength of the absolute correlation coefficient: 0–0.3 - weak, 0.31–0.7 – moderate, 0.71–1.0 - strong.

The focus of the study then turned to building linear regression models for ROE and ROA. All independent variables were entered into the equation in a single step, using *Enter* multiple regression method. The functional forms of the models are as follows:

$$ROE = b_{1,0} + b_{1,1} * TA + b_{1,2} * CR + b_{1,3} * GDP + b_{1,4} * INT + \in_1 \quad (1)$$

$$ROA = b_{2,0} + b_{2.1} * TA + b_{2,2} * CR + b_{2,3} * GDP + b_{2,4} * INT + \in_2 \quad (2)$$

where $b_{i,0}, b_{i,1}, b_{i,2}, b_{i,3}, b_{i,4}, \ i = 1, 2$ are coefficients to be calculated and $\in_1$ and $\in_2$ are stochastic error terms. The performance of the model was assessed by using ANOVA method and by testing the hypothesis $H_0(b_1 = b_2 = b_3 = b_4 = 0)$ against the alternative H_1, which presupposed the existence of at least one coefficient different from zero. All statistical tests were performed based on statistical significance at the level of 5%. Standards goodness-of-fit measures for linear regression models were then computed, such as the coefficient of determination R^2 and its adjusted version $\overline{R}^2$. The collinearity among independent variables was examined through the Variance Inflation Factor (VIF). The standard criteria analysis was applied to this purpose: $VIF < 5$ suggests that there is no multicollinearity among variables, while all values greater than 5 indicate that additional analysis is necessary.

4 Results

Montenegro's economy is heavily reliant on tourism[1], so this sector of the economy, expectedly, suffered the biggest blow from the pandemic. Payment transactions have been reduced[2] which has led to a drop in the banks' net fee income. The demand for

[1] Income from tourism in 2019 was €1.2 billion. GDP in the same year was €4.9 billion.

[2] Domestic payment transactions in Montenegro in April 2020 were down by 32,98%, compared with the same period last year.

loans and bank services has also dropped and so has the banks' interest income. To mitigate the negative effects of the pandemic, the Central Bank of Montenegro introduced a moratorium on all loan repayments for the period of 90 days. The purpose of introducing a moratorium on loan repayments was to help borrowers avoid falling behind on loan repayment and to prevent an increase in credit risk.

What emerged from the interviews with bank representatives is that bank controlling has been put to a serious test following the corona pandemic. Providing an effective support for decision making process has become challenging. Each bank in Montenegro has a controlling function set up within their respective organizational structures. However, the actual scope of the controller's role in Montenegrin banks is best labeled as "*navigator*", to borrow the terminology used by the authors cited above. The primary tasks of the controller are reporting to the shareholders and management, cost control and budget planning. The organizational structures of the commercial banks covered by this study have the function of controlling positioned within the Department of Finance (at the third level of hierarchy), rather than having it placed in a direct support position at the top management level. The controlling tools such as *balance scorecard*, and *data mining* are not well understood or used in the controlling process[3]. Preparing a realistic budget presents a challenge for controllers in the current pandemic situation.

Table 2 below gives the descriptive statistics (minimum, first quartile, median, third quartile, and maximum) for both dependent and independent variables. The minimal ROE and ROA values in 2010 were due to the allocation of additional loan loss provisions for uncollected loan payments, following the financial crisis.

Table 2. Descriptive statistics of variables

		TA	CR	GDP	INT	ROE	ROA
Mean		3.13	5.03	3.38	2.43	−1.78	−0.08
Std. deviation		0.86	1.81	4.71	1.25	13.91	1.52
Minimum		0.69	1.68	−10.90	0.41	−38.45	−4.14
Maximum		4.70	7.94	18.20	4.28	12.89	1.56
Percentiles	25	2.89	3.92	1.25	1.05	−12.91	−1.26
	50	3.07	5.21	3.60	3.08	4.10	0.50
	75	3.61	6.47	5.20	3.40	7.98	1.00

The results of the correlation analysis presented in Table 3 provided a starting point for the analysis of the relationship between dependent and independent variables. The results indicate a *statistically significant correlation* between ROE and each of the independent variables TA, CR, GDP, and INT. The results also demonstrated a weak positive

[3] The controller has to be prepared to detect early signs of changes in customers' behavior, prevent customer churn and their leaving the bank, propose innovation, provide performance and seasonal information and analyses to be used as input for predictive decisions and cost modelling, assess the effects of marketing campaigns etc.

correlation between ROE and TA, and moderately positive correlation between ROE and GDP. ROE is weakly negatively correlated with CR and moderately negatively correlated with INT.

Table 3. Correlation analysis

		TA	CR	GDP	INT
ROE	Pearson Correlation	.192*	−.224**	.422**	−.542**
	Sig. (2-tailed)	0.013	0.004	0.000	0.000
ROA	Pearson Correlation	.198*	−.188*	.389**	−.550**
	Sig. (2-tailed)	0.010	0.015	0.000	0.000

**Correlation is significant at the 0.01 level (2-tailed).
*Correlation is significant at the 0.05 level (2-tailed).

Table 4 provides a summary and validation of the ROE and ROA linear regression models.

Table 4. Model's validation and summary of results

Model	Model summary		ANOVA	Sig.
	R Square	Adjusted R Square	F statistics	
1: ROE	0.495	0.483	39.965	0.000
2: ROA	0.476	0.464	37.080	0.000

The values of coefficients of determination of both models show that almost 50% of the dependent variables were predicted by the selected independent variables. F statistics for ROE and ROA, and its significance level suggest that there is a significant linear relationship between predictors and the dependent variable. This means that both models can be considered statistically valid and their estimations significant.

Based on the regression coefficients given in Table 5 and Table 6, respectively, we can estimate the models as follows:

$$ROE = 33.818 - 3.516 * TA - 1.497 * CR + 0.714 * GDP - 8.015 * INT \quad (3)$$

$$ROA = 3.882 - 0.418 * TA - 0.142 * CR + 0.070 * GDP - 0.897 * INT \quad (4)$$

The regression coefficients were tested based on the t-statistics and the value of Sig. All model variables had a significant impact on ROE. ROE was negatively affected by TA, CR, and INT, and positively by GDP. From the correlation Table 4, we can see that TA is positively correlated with ROA and ROE. However, when included with other predictors, TA has a negative relationship with both, ROA and ROE. This occurs due to

Table 5. Linear regression model: ROE

	Unstandardized coefficients		t	Sig.	95.0% confidence interval for B		Collinearity statistics	
	b	Std. Error			Lower bound	Upper bound	Tolerance	VIF
Constant	33.818	6.860	4.929	0.000	20.271	47.365		
TA	−3.516	1.340	−2.624	0.010	−6.162	−0.870	0.448	2.231
CR	−1.497	0.515	−2.910	0.004	−2.513	−0.481	0.694	1.441
GDP	0.714	0.197	3.617	0.000	0.324	1.104	0.694	1.441
INT	−8.015	0.916	−8.746	0.000	−9.824	−6.205	0.454	2.203

the intercorrelations between the independent variables in the complex model. In spite of the country's GDP growth following the financial crisis, banks continued pursuing restrictive credit policies. Banks' high coverage ratios[4], which increased during financial crisis, remained flat in the period after the crisis. The result was a decline in banks' total assets, improved quality of their loan portfolios with low risk cost allocation for loans, and improved profitability. Net interest margins shrunk due to the decrease in interest rates on deposits, which had a negative impact on banks' profitability. The coefficients from regression model show that a GDP increase of 1% led to a ROE increase of 0.714%. The values of VIF for variables range between 1.441 and 2.231, which, according to the set criteria, suggests absence of multicollinearity between the independent variables in the regression.

Table 6. Linear regression model: ROA

	Unstandardized coefficients		t	Sig.	95.0% confidence interval for B		Collinearity statistics	
	b	Std. error			Lower bound	Upper bound	Tolerance	VIF
Constant	3.882	0.762	5.092	0.000	2.376	5.387		
TA	−0.418	0.149	−2.808	0.006	−0.712	−0.124	0.448	2.231
CR	−0.142	0.057	−2.480	0.014	−0.255	−0.029	0.694	1.441
GDP	0.070	0.022	3.182	0.002	0.026	0.113	0.694	1.441
INT	−0.897	0.102	−8.805	0.000	−1.098	−0.695	0.454	2.203

As shown in Table 6, all bank-specific and macroeconomic indicators are statistically significant for ROA as well. The regression results demonstrate a positive impact of GDP

[4] Coverage ratio is calculated as the allocated loan provision divided by the on-performing loan portfolio.

and negative impact of TA, CR, INT on ROA. The values of VIF are acceptable, showing that multicollinearity assumption is not violated.

5 Conclusion

Bank controlling has an increasing role in Montenegro's banking sector, but its importance is still not fully recognized by the banks' managements. The main focus of the controlling function in Montenegrin banks is reporting, budgeting and cost control.

The profitability of the bank sector in Montenegro in the future will be affected to large extent by the adopted macroeconomic policies, and the further impact of the global pandemic on the country's economy. The developed regression model confirmed the hypothesis that TA, CR, GDP and IR have a significant impact on the banks' ROE and ROA. The COVID 19 pandemic hindered prediction of macroeconomic and banking indicators during the economic recession. Based on the IMF's prediction that the country's GDP in 2020 will shrink by 9% [14], it is estimated that the banking sector's ROE will decrease by 6,426%. This study is intended to help the commercial banks and policy makers in Montenegro improve banks' profitability.

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Media and Sport: Mutual Benefit

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Abstract. Sport has played a significant role in the growth and development of mass media, especially television, since the formative phase of their emergence. On the other hand, the mass media attracted commercial sponsorship to sports events, thus contributing significant revenues, both to sports clubs and to the media outlets themselves. The positive effects of media coverage of sports are in education about the importance of sports and sports rules, in creating sports role models, encouraging sports, and the development of sports journalism. A survey conducted on a sample of 120 participants showed that for over 60% of them, television is still the most watched media outlet when it comes to sports events. Slightly less than half of the respondents were of the opinion that there should be more articles about sports in the mainstream media. Also, close to a third of the respondents stated that they dedicate from two to as many as five hours a day to television reports on sports. When it comes to journalistic genres that represent sports and sports events, interesting answers were obtained. Namely, a significant percentage of respondents thought that sports television reports, in terms of genre, should be of the documentary type, and in correlation with that, it was stated that there is a lack of quality analysis of sports events. This indicates that sports journalists, although very competent in their field, do not have the opportunity to do serious investigative work in sports journalism.

Keywords: Media · Sports · Investigative sports journalism · Media audience

1 Introduction

In modern society, activities within the media, as an industry of mass communications, and sports have reached an extraordinary development. Without the media and media audience, sports games and competitions would lose their substance. This makes sport an attractive and lucrative activity. Sports and mass media try to reach as many spectators, fans and consumers as possible, actively influencing the audience, as well as the advertising market (including sponsors).

The positive effects of media coverage of sports are visible in the following: in education, because the audience learns about the rules of sports, in creating role models by following the activities of top athletes, which contributes to creating role models for media audiences, as well as in helping them play sports and training. Negative effects presuppose the following phenomena: a) bias (only very popular sports get a lot of media attention, and this is not helpful to people trying to affirm themselves in less popular

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 261–268, 2022.
http://doi.org/10.1007/978-3-030-97947-8_35

sports); b) overload (too much sports content in the media); c) too much media exposure (sports stars often complain about too much attention being paid to their private lives).

The relationship between the media and sports is reflected not only in the media promotion of sports and information about sports events and athletes, but also in the strong commercial connection between the two industries. The media helped to move sports from the amateur framework to the high-profit industry, while sports enabled the spread of media and their influence through a huge audience related to sports [2]. In that sense, it can be said that the media and sports, especially professional ones, are in a kind of symbiosis [3], from which both sides have great benefits. Let's just give an example of a contract on the rights to broadcast sports events, which are worth millions of euros and are constantly growing.

The popularization and commercialization of sports is the first benfit brought to sports by the mass media. According to Otašević [4], the marketing transformation of great sporting events into spectacles has the characteristics of planetary phenomena. Such sports spectacles bring great economic benefits to the host, whether at the level of the city, region or the entire country, and on the other hand, the media, due to the introduction of licenses and fees for broadcasts, have extremely high ratings, but also economic benefits.

The reciprocity of influences, as well as the benefits of this relationship, are areas of different interest. First, media coverage of sporting events is one of the important sources of income for media operators and an important factor in initiating the development of new platforms for the distribution of audiovisual content [5].

Secondly, given the social role of sports, on the one hand, and the role of mass, on the other hand, the question arises of defining the boundaries and scope of legal protection of this relationship. This issue is a major challenge for national and European regulators.

Thus, in Serbia, the national source of law is the *Law on Electronic Media* from 2014 [6], in which Article 64 regulates "that the exclusive right to broadcast sports events has only the provider of TV broadcasting to which access is free and whose coverage area covers the entire territory of the Republic Serbia and the regulator are obliged to inform the European Commission about that. A television broadcasting service provider under the jurisdiction of the Republic of Serbia may not exclusively broadcast events that are on the list of the most important events of special importance to all citizens, in such a way that a significant part of the public in the Republic of Serbia, EU member state or signatory state to an international treaty that is obligatory to the Republic of Serbia, deprives him of the possibility of following those events". The advantage of television broadcasting is confirmed by the findings of our research, which proved that, in addition to other electronic media, TV broadcasts of sports programs have the highest ratings.

Having in mind all the above, we researched the role and importance of Serbian media in the promotion of sports. The goals of the research were to determine the attitude of research participants towards media promotion of sports and sports events in Serbian electronic media, with emphasis on television, the length of coverage of these contents, as well as satisfaction with the quality of sports reporting. The research was conducted using a survey method.

2 Research

2.1 Research Subject, Goal and Sample

The questionnaire was constructed for the purposes of this research and consists of three parts: (1) sociodemographic data, covering five questions (2); sport, covers five issues and (3) sport in the media, which covers 21 issues. The format of the answers to the items is of a mixed type, with questions with a scale of answers of the Likert type, multiple choice and open type of answers.

The gender structure of the research entities is characterized by the participation of a total of 120 respondents, of which 57% were male and 43% female. The age of the respondents ranged from 18 to over 60 years, among which the largest percentage of participants was aged from 18 to 29 years (60%), then from 30 to 44 (32.5%) and between 45 and 59 years (5%), and only 2.5% of respondents in the age category over 60 years. The professional qualification of the respondents was detected through six levels of education, which are usually observed in this type of research. The participants in the research were dominated by respondents who completed basic academic studies (35.8%), followed by master studies (23.3%), and those who completed high school (29.2%). The percentage of respondents with basic vocational studies was 10.8%. Only 0.8% of research participants had the highest level of education (PhD). None of the respondents belonged to the group that had primary education.

In terms of employment, the results of the survey showed that the majority of respondents are employed, that is most of them are permanently employed (64.2%), while 8.3% were unemployed. The student population was 23.3% of the research participants, and high school students constituted 2.5%. Only 1.7% of respondents belonged to the category of pensioners. The sample was selected by random method, but there is a certain disadvantage of the sample in that it was not balanced in terms of age structure. We assume that the fact that there were the fewest older respondents in the sample was conditioned by the way of surveying, ie, online surveying, which is used less often by older research participants.

2.2 Research Results

Doing Sports in General. The results of the research showed that 54.2% of the research participants are engaged in sports, mostly recreationally, while 45.8% are not engaged in any sports activities. The reason why our respondents do not engage in sports activities is most often attributed to lack of time. In that sense, the respondents' answers to the indicator that "the modern pace of life causes the lack of free time for physical activities" were also detected. The largest number of respondents (66.6%) agreed with this statement, while 30.8% of them did not accept this statement. Only 2.5% of respondents said they had no opinion on the matter.

Informing About Sports Through the Media. When asked how much space in the media is dedicated to sports, half of the respondents (50%) answered that sport is largely represented in the media, while 40% of them were of the opinion that it is insufficient in the Serbian media. Only 10% of the participants in the research stated that they would like some other topics to be more represented in the media, which presupposes that they thought that there was too much sports content in the media.

Regarding the length of exposure to sports content, more than half of the research participants (56.7%) answered that they do it for less than one hour a day, while 29.2% of them spend between two and five hours a day with sports reports. Observed on the weekly level, 6.7% of respondents follow sports events for more than ten hours a week, while 7.5% of survey participants follow these contents between five and ten hours during one week (see Fig. 1).

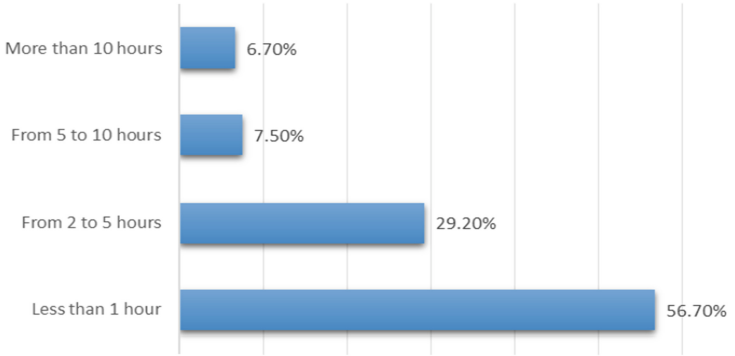

Fig. 1. Length of viewing sports content.

The largest number of research participants stated that they most often watch sports on television (60%), both on mainstream TV channels and on specialized sports TV channels. Slightly less than a quarter of them (24.2%) watch sports on a mobile phone, while on a computer that percentage is 13.3%. The most frequently watched sports channels are the following: Arena Sport (65.8%), Sport Klub (51.7%), Eurosport (20%), Fight Channel (4.2%), SOS Channel (2.5%), Extreme Sports (1.7%) and Nova Sport (1.7%).

When it comes to social networking sites, research has shown that they are also a significant source of sports information for most respondents. Survey participants most often cited the social network Facebook (71.7%), followed by Instagram (50%), while 31.7% of survey participants most often followed YouTube as a source of information about sports. A significantly lower percentage of respondents cited networks such as Reddit (0.8%), Snap Chat (0.8%) and Viber (2.4%).

Research participants were of the opinion that some sports are overrepresented in the electronic media (for example, football – 88.3%, basketball – 43.3% and tennis – 49%), and some are visibly neglected (for example, table tennis – 43.3%, gymnastics – 40.8%, archery – 37.5%, handball – 22.5% and cycling – 11.7%). In addition, the results of the

research showed that the media generally pay less attention to women's sports (30.8%), and when they do, they mostly report only on the successes of top athletes (48.3).

When it comes to the types of journalistic genres that are most attractive in sports reporting, the following answers were obtained: 24.2% of research participants prefer the documentary form of reporting, and 25% of them opted for critical analysis of sports events, athletes and sports policy. About 28% of respondents prefer to follow personal conversations (interviews) with athletes, while a fifth (20.8%) of research participants opted for *highlights form*, i.e. a shortened version of sporting events (see Fig. 2).

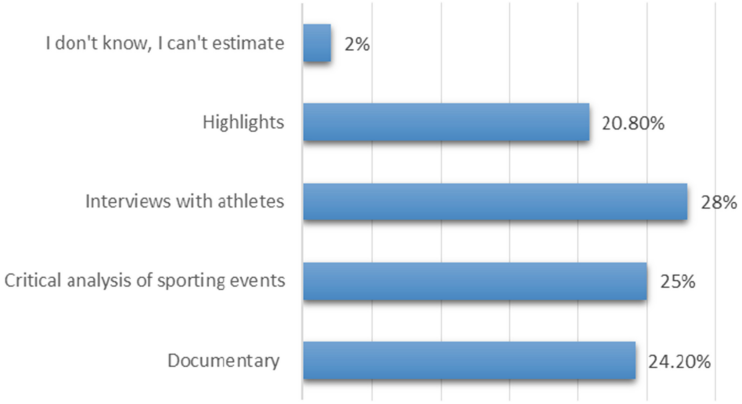

Fig. 2. The most popular media genres in sports reporting.

Sports Journalists and Sports Journalism. One of the most common forms of media writing is sports journalism. Today, sports journalism is an important part of the media industry. Among the main actors in the world of sports, apart from athletes, are also sports journalists whose work pretty much conditions the success of sports newsrooms. Sports journalists, although ridiculed in the early days of sports journalism for not being "serious writers", have become significant factors in a multibillion-dollar industry. In this sense, it can be said that "sports journalism is a special type of journalism that announces, transmits, comments and analyzes sports events and related topics after they are completed, and an indispensable part of this process are: sports events, information, media and sports journalists" [7].

When asked how they evaluate the work of sports journalists in the domestic media, 23.3% of survey participants were of the opinion that they are well informed and professionally competent. More than a third of the respondents (37.5%) were more critical, and rated the work of sports journalists as average, while 15% of them thought that Serbian media journalism was not at the required professional level. A significant percentage of respondents – 24.2% could not assess the quality of work of sports journalists, although, with varying frequency, they follow sports content in the media (see Fig. 3).

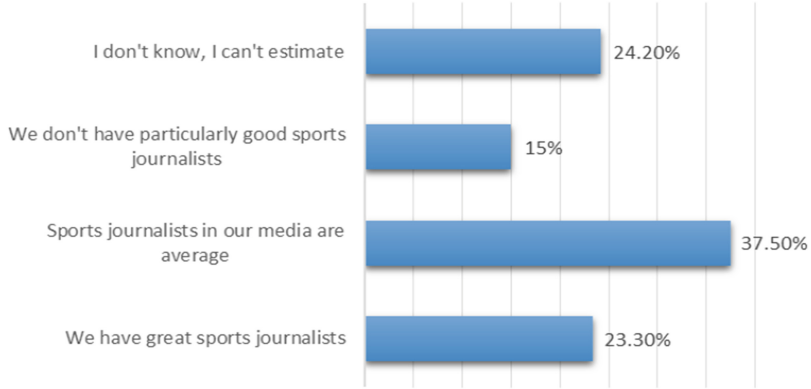

Fig. 3. Competence of sports journalists.

When it comes to sources of sports information, the question is whether there is too much news in media reporting on sports that is directly downloaded from digital media sources. Less than half of the research participants (41.7%) thought that this statement was true. A quarter of the respondents, 25.8% of them, did not agree with the stated statement, believing that it was a general trend in journalism, primarily in the mainstream media. The same percentage of survey participants (25.8%) could not answer this question, given that they were not familiar with authentic sources of information.

Respondents' opinions were divided on whether the direct download of sports information from digital media undermines the possibility of investigative journalism and the authenticity of the journalistic story. According to the obtained results of the research, 34.2% of the respondents thought that the stated statement was true, believing that it violated the professional autonomy of the sports journalist. According to the responses of 16.7% of survey participants, a journalist reporting on sporting events is generally unable to verify downloaded information. One fifth of the respondents, 25.0% of them, were of the opinion that the use of information from digital media achieves the speed of reporting, and that this is a general trend of media reporting, especially in the mainstream media. Although the majority of survey participants (58.3%) had the opinion that sports reporting has become much more efficient and extensive in terms of content, thanks to social media, as well as official announcements of sports organizations or athletes, about 40% of survey participants expressed a more critical attitude. Namely, these respondents were of the opinion that professional sports journalists no longer have enough space to independently and critically evaluate a certain sports event, given that the information was "served" to them in a way that suits sports organizations or the athletes themselves.

Considering that women – sports journalists – are slowly entering media sports journalism, we also investigated this phenomenon. The results of the research showed that 35.8% of respondents thought that sports journalism should not be "reserved" only for men, nor that they have more trust in the reports of a male sports journalist (34.2%). However, about 6.0% of survey participants disagreed, stating explicitly that male sports journalists are still better and more professionally reliable. Let us add 20% of those who were undecided on this issue to this group of respondents, which can be interpreted in

two ways: either as a form of having insufficient information or as a certain resistance to female journalism in sports.

Finally, it was inevitable to ask the question about the status of sports journalists in relation to journalists specialized in others, the so-called more serious areas. One third of respondents (32.5%) were undecided about the claim that sports journalists were underestimated in relation to journalists covering other areas, while 29.2% of them did not agree with this statement. Nevertheless, about 8% of survey participants were of the opinion that sports journalists do not have a sufficiently recognized status in the overall journalism industry (Table 1).

Table 1. Attitudes of research participants about sports journalism.

Claims	Strongly disagree %	Disagree %	Undecided %	Agree %	Strongly agree %
It would be more helpful for the development of sports if sports journalists had greater freedom to present the essence of the problem in the field of sports	6.6	9.2	31.7	40	12.5
Some sports journalists have reached the level of the most credible sources of information about sports	5.9	14,2	41	33	5.9
Sports journalism should be a field dominated by men	35.8	33.3	14.2	10.8	5.9
I value the views and opinions of a male sports journalist more than a female journalist	34.2	31.7	20	8.3	5.8
Sports journalists are underestimated compared to journalists who cover other areas	17.5	29.2	32.5	13.3	7.5

3 Discussion and Conclusion

Media and sport are indisputably linked. Mass media encourage general visibility and attractiveness of sports. Research on the role of the media in the promotion of sports has shown that sports are represented in the media in a high percentage compared to

other content, and that the media audience is most often informed about sports topics by watching TV shows or specialized TV channels, as well as through social networks.

Our research confirmed that most of the participants in the research, in addition to traditional media, also use social networking sites to follow sports, sports events and sports personalities. Respondents showed some criticism of the lack of space for sports journalism on social networking sites. Also encouraging is the data that most respondents were of the opinion that a profession such as sports journalism is no longer the privilege of only men and support the entry of female sports journalists into media coverage of sports.

The economic aspect of the symbiosis of sports and media is a key reference point for the further development of television stations. That fact connected sport with marketing and sponsors. The media thus included equipment manufacturers and athletes in the promotion of sports, and introduced them to the general promotion.

However, the existence of a negative influence of the media on sports can also be noticed from the research. Namely, the media imposes the logic of entertainment for the widest audience. This is reflected in favoring sports, such as football, basketball or tennis, using their more fun character. Favoring these types of sports, by providing longer broadcast time in the program, opens up more space for the influence of advertising agencies and sports equipment manufacturers. This has led to the media focus being not only on sporting events but also on top athletes, who are constantly under pressure from the media due to their high salaries, that often use tabloid principles of journalistic reporting in their stories.

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Lean Approach to Lead Time Reduction in MTO Manufacturing: A Case Study

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Abstract. In order to improve operational performance, many companies adopted lean approach in their manufacturing processes. Although most of those companies revealed to be effective in lean implementation, small and medium-sized make-to-order (MTO) companies, faced with high mix and low volume production, had difficulties to implement lean. The mix of orders and the specific demands of every customer can increase the time from the placement of an order to the delivery to a customer. In that case, lead time can be long since the process typically includes steps such as ordering/sales, design, adjustment, procurement, production, assembly, delivery and installation. In order to reduce lead time in manufacturing processes, implementation of lean approach can be of great benefit. For that purpose, this paper analyzes lean approach applicability to MTO companies. The paper presents the implementation of lean in MTO manufacturing company that deals with the production of custom furniture. The results were obtained through systematic identification and elimination of wastes in all phases of the process, and show that significant lead time reduction can be achieved through lean implementation in MTO manufacturing.

Keywords: Lean approach · Make-to-order · Lead time

1 Introduction

Lean approach has been receiving attention lately from lots of companies. The lean approach has its origins in Japanese car plants, when their manufacturers realized that they failed to manage a huge investment in rebuilding existing facilities [2, 7]. According to the Kazancoglu [6] the lean approach can be defined as a methodology for eliminating waste, improving satisfaction and continuous improvements of processes in companies. Many authors have documented various quantitative and qualitative benefits of implementation of lean concept, such as improvement in lead time reduction, increasing job satisfaction, establishing standardized operations, etc. However, the possibilities of lean implementation in make-to-order (MTO) companies differs significantly from the surroundings lean was originally developed in. Although there is an interest for MTO context relative to implementation of lean approach, the literature on lean approach implementation in MTO companies stays limited compared to repetitive manufacturing [11]. For

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 269–277, 2022.
http://doi.org/10.1007/978-3-030-97947-8_36

this purpose, this research investigates in more detail and analyze the possibilities of lean methodologies implementation in the special areas of MTO environment.

Lean approach generally comes from product-focused, repetitive, and to-stock type of manufacturing, categorized by stable demand for high volumes of similar products [11, 15]. These companies produce products for stock according to demand forecasts and with low costs, so the products are defined long before the customer makes the order [9, 14]. On the other hand, MTO products contains a large set of pre-defined factors that the customer can choose, so the product will be manufactured according to the selected configuration [8]. It is characterized by unpredictable demand of often customized products where each product may have different process flow and processing times. Production process in MTO companies is performed in a special way, because customers are offered a product that is made according to their requirements, so they are specific in organizing the entire production. As customer is involved in all phases of the internal supply chain phases (e.g. design, procurement, delivery and installation etc.), cumulative lead times can be very long. Since short lead times are order winning characteristic in MTO industry, it is important to explore possibilities for lead time reduction through lean implementation [4]. However, recent research shows that lean implementation in MTO manufacturing mostly targets shop-floor, while other phases of internal supply chain, that can constitute a large portion of a total lead time, remain largely unaddressed [11]. In order to fill this gap, this research aims to investigate how lead time in MTO manufacturing can be reduced by extending lean implementation beyond shop-floor, and directing it to all phases of internal supply chain simultaneously.

This research was conducted as follows: the second section will be based on theoretical background of lean approach and lean implementation applicability to MTO companies. The third section propose research methodology choosen for case study in manufacturing company. Results of the research are presented in section four, which will be followed by conclusion in fifth section.

2 Theoretical Background

Lean concept came from Japan from Toyota company as approach for production improvement. Lean gives attention to how the value in processes is produced, but not all activities that occur in a company adds value. The value is defined by the user, and is expressed by the performance of the product, which most often refers to the quality of the product, price and delivery time [10]. Also, the five lean principles can help a company to [1, 15]: identify the value of the process, identify the process flow, eliminate many types of waste, optimize the process flow and pursue perfection through continuous improvement. Lean approach is a philosophy that focuses on removing wastes from processes and shortens lead times by eliminating wastes between ordering and delivering product to the customer [12, 15]. According to lean approach, the production without waste requires less investment in resources, shorter lead time, less stocks, etc. As a basis for defining waste, it is necessary to classify the activities of the company as [5]: value adding, non-value adding and necessary non-value adding activity. Many companies have also implemented different methods of improvement like just-in-time, kaizen, kanban, poka-yoke, which can be the solution in the long run for process improvement and lead time reduction.

For small and medium-sized companies, lean is a good opportunity to improve production efficiency, because they offer continuous improvement in addition to what is very important for the company - low costs. Most frequently, the weaknesses of the company are mostly reflected in the production process at the workplace. Lean production process is primarily focusing on producing only certain quantities of those products that can be sold on the market [12]. Therefore, quality, lead time and price are variable and depend on the specific requirements of the customer. In the case of MTO production, the unpredictability of customer requirements and the adjustment to their requirements results in the unpredictability of demand, production cycle and lead time. It is characterised by low volumes of often unique products that require product design, which would require the procurement of specific material, production of a unique product, delivery and installation [3]. Products are often configured to contain large set of pre-defined elements that customer can choose [14]. The response time to the user's request is longer with such production systems, because its lead time consists of the time required for the product design, procurement of materials, the production time and the time required for the delivery of the finished product [10]. On the other hand, the customer expects to get the product in the shortest possible lead time, so the companies needs to fulfill the requirements of customers to achieve flexibly in shorter lead times to remain competitive [3, 16]. This causes the need for a company to improve its business in order to achieve the expected results.

3 Research Methodology

The case study was choosen as a methodology for this research. The case research can provide the full understanding of complexity and nature of the observed phenomenon, through relevant theory and exploratory investigations where the variables are still unknown or not at all understandable [13]. The review of literature supports the case research and the need to investigate the lean approach applicability in MTO environment for lead time reduction. This study observes whole internal supply chain in the case company, for ordering process to the delivery and installation of a final product. Each process in supply chain was analyzed from adding-value aspect to identify problems and give potential directions for waste elimination and process improvement in MTO manufacturing company, in order to reduce lead time reduction.

The observed case company is a small sized enterprise, which makes different types of furniture. All the products are designed and manufactured based on the customer orders and their requirements. This approach gives company competitive advantage, because making the high customized products have an added value that distinguishes them from standard pieces of furniture. In this company the production of every product begins when there is a direct order from the customer so products are unique. Also, this production system produces different products in small volumes. For that purpose, it is necessary to find a way to achieve balance between available capacities, stocks and customer requirements. Unpredictability and variations in demand as a consequence have instability in the range of products offered, as well as in the volume of production [10]. The causes are variations in the amount of product that needs to be produced with each new order, as well as in the time at which new orders arrive. Because of that, the

company tends to minimize the lead time required for every order. This research intend to investigate the main causes for long lead time in supply chain of the company. Problems mostly occur because of the wastes in processes, so the directions for their elimination were identified through this research.

4 Results

Within the observed company, the lead time of the order includes the time from the receipt of the customer's order to the moment when the products are delivered and installed. The core business processes include the core processes Ordering, Product design, Adjustment, Procurement, Production, Assembly, Delivery and installation. In Table 1 is given the description of basic activities for every core process.

Table 1. Overview of core processes in company

Core processes	Basic activities in process
Ordering	Receiving the order for the product from customer, negotiation and making the specification of desired product. The process includes making preliminary drawing, material selection and selection of additional elements. Negotiation can be done in the store or at the customer, depends of their requests
Product design	Design of product and products elements, creating documents for following processes, such as Bill of material and Cutting list. Customized elements take longer to design in the product design process. The design process depends on the ordering process, because of the customer requests
Adjustment	It includes final checks, approvals and change requests from the customer side. This may result in some changes in product specifications and documents made in the previous processes
Procurement	Purchasing of elements according to Bill of material and Cutting list. Some products have standard elements which will always be required and they are on stock. Other elements must be purchased when the order, design and adjustment is completed
Production	Four main phases can be distinguished: tailoring, machining, varnishing and assembly of elements. This process includes supporting processes: technological and operational preparation, planning, and storage of elements
Assembly	Assembly of final product according to the product documents. This process depends on product specifications and often assembly has no predefined steps for any of the products
Delivery and installation	Packing, shipping, installation and finishing works on a final product

The ordering process is key for establishing cooperation between the company and the customer and ensuring the future processes. When the ordering process is finished, the following process of product design is closely linked with the production by generating the Bill of material and cutting list used for procurement, and for developing the documents needed for production and assembly of the product. Their application enables grouping of the same or similar elements that are made of the same material, according to the same technological procedure, in order to organize small series instead of individual production of parts. In MTO production, during the production process can be found repeating activities. Every order may include parts and elements that are standardized, or that have never been developed before. For example, drilling holes in kitchen doors and assembling handles when making a kitchen is an activity that is repeated for each kitchen part. On the other hand, production planning in the observed company includes setting deadlines for the beginning and completion of work on product development, resource planning for the start of the production process and planning the preparation of input raw materials, the necessary tools and documentation. It is necessary to make a time plan from the beginning to the end of all operations in the production process.

The goal of both the company and the customer is to minimize the lead time required to deliver the finished product. In order to determine the lead time of making product, Fig. 1 gives the estimated duration of all phases necessary for the realization of one order, for producing a custom-made kitchen.

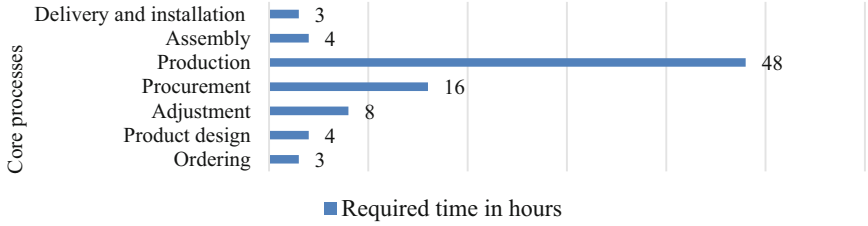

Fig. 1. Required time for one order in hours

During the analysis situation of the process, different value-adding, non-value-adding and necessary activities can be identified. Analysing the wastes in processes, certain problems were identified, which can be significant during the implementation of lean approach in MTO company. The adding-value activities in core processes are:

- Ordering - defining design, elements, materials and built-in elements; defining contract conditions; taking accurate measures.
- Product design - elaboration of product design; product design in a program; making Bill of material and cutting list.
- Adjustment - customer confirmation.

- Procurement - making time plan for procurement according to product prioritization; purchasing on time according to production start.
- Production - making a term plan; job preparation; tailoring, machine processing, painting and/or varnishing, assembly of elements.
- Assembly - product assembly; packing of transport elements.
- Delivery and installation - transport of product; product payment; installation.

Table 2 indicates sources of waste affecting lead time in the MTO activities. The directions for waste elimination have been developed based on the lean approach, which will achieve lead time reduction.

Table 2. Directions for waste elimination and lead time reduction in MTO core processes

Core processes	Wastes affecting lead time in MTO core processes	Directions for waste elimination and lead time reduction
Ordering	Negotiation about the product specifications	Defining instructions for the ordering process that will reduce time with the customer. Standardize documentation based on previous orders with similar specifications
	Indecision about material and design	Making a form that the customer can fill out online before the meeting
Product design	Re-measuring due to the inaccuracies	Define quality check points before the final product specification
	Transformation of contract into product specifications	Establish software compatibility with product design and documentation, which is an important factor for software implementation
Adjustment	Adjustment with the spatial layout	Involve production department in product design to reduce the possibilities for wastes and defects in production

(*continued*)

Table 2. (*continued*)

Core processes	Wastes affecting lead time in MTO core processes	Directions for waste elimination and lead time reduction
	Customer wants the correction of design	Establish experience-based learning processes. Improve the negotiation process by considering problems that have occurred in the past in design and adjustment process
Procurement	Lack of material in stock	Define the procurement according to the lead time. Predicting the demand for frequently used material for stock, so the procurement can be realized before demand arises
Production	Preparation is not adequately done, so the production is waiting	Digitalize access to work instructions and product documents. Reduce the time spend for preparing for the process, looking for materials, tools and product documents needs for production of a product
	Lack of materials for production	Provide the items with long lead time on time, in order to ensure availability before production start
	Non-compliance with the plan	Make a production time plan according to the product prioritization and available production time
	Variations in production	Define standardized operations for similar customized products as much as possible
Assembly	Corrections if the elements do not fit	Define quality check points before the final product is delivered. Establish synchronization with the production
Delivery and installation	Additional requirements	Consulting with the customer before delivery and installation

Each of the direction for waste elimination and lead time reduction presented are developed to solve a specific critical source of waste. By applying the proposals for eliminating waste, maintaining the orderliness of the workplace, applying the standard operation and the proposed solutions, it is possible to significantly reduce the lead time required for the realization of the order. In order to determine the benefits of their implementation, possible time savings were estimated (Fig. 2). After the realized time savings, the total lead time would be reduced from 86 h to 70 h.

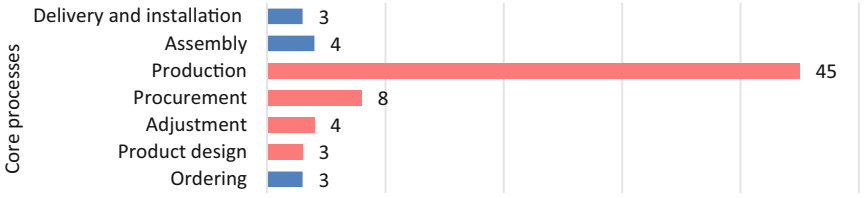

Fig. 2. Estimated lead time reduction after waste elimination for one order

5 Conclusion

In order to reduce lead time in manufacturing processes, implementation of lean approach can be of great benefit. For that purpose, this paper analyzes lead time reduction in case company that deals with the production of custom furniture using lean approach. This research identified a set of critical wastes in core processes affecting lead time in MTO company. Also, the contribution of this research is elimination of wastes in whole internal supply chain, not only shop-floor level, which contributes lead time reduction.

The identification and elimination of wastes in processes needs to be based on a good knowledge of the enterprise, so the problems and their causes can be identified. The result showed that waste elimination has positive influence on lead time reduction. By focusing on the entire internal supply chain, the lead time could be reduced up to 16 h, while focusing only on production (shop-floor), the lead time would be reduced for 3 h.

As MTO is very complex, limitations of this paper are that the research was applied only in one company and it was briefly applied. So the extended analysis of the case company can be made, because there is still large potential for lead time reduction and reduction of costs. Besides that, with the extended research and implementation of different improvement technologies in case company, proposed solution should give a synergetic approach for lead time reduction and can bring more improvements. Also, further research should include the application of this methodology in other companies to make a comparison of benefits related to the reduction of lead times and costs, so that more conclusions can be drawn at all.

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The Outcomes of Lean Implementation in High-Mix/Low-Volume Industry – Literature Review

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Abstract. Many companies in the world have used lean to achieve significant improvements in both efficiency and effectiveness. However, most evidence of lean implementation stem from manufacturing environment similar to one lean was developed in, i.e. product-focused and to-stock Low-Mix/High-Volume (LMHV) manufacturing. High-Mix/Low-Volume (HMLV) industry, on the other hand, is usually process-focused, with to-order manufacturing, and as such it comes with specific set of goals and priorities, and possibly different set of lean implementation outcomes. This paper aims at investigating the outcomes of lean implementation with a specific focus on High-Mix/Low-Volume. For this purpose, a systematic literature review procedure was conducted, in order to analyze implementation reports from state-of-the-art literature. The results show that HMLV companies mostly report efficiency related, easily quantifiable outcomes, stressing the positive side of lean. What literature lacks to report are intermediary outcomes (e.g. better understanding of processes, teamwork and collaboration, problem solving abilities), as well as results regarding customer satisfaction. In addition, reports also lack the issue of outcomes sustainability, as most papers show evidence from short-term case studies.

Keywords: Lean implementation · High-mix/low-volume · Systematic literature review

1 Introduction

Since its inception, many companies have implemented lean with the goal to improve their efficiency [1, 6]. Most evidence of successful lean implementation come from product-focused, repetitive, and to-stock manufacturing, characterized by relatively stable demand for high volumes of similar products (Low-Mix/High-Volume or LMHV industry) [6, 7, 15]. On the other hand, evidence regarding lean implementation in High-Mix/Low-Volume (HMLV) industry is scarce. Specificities of this type of industry (e.g. unpredictable demand for low volumes of customized products, to-order manufacturing, and process-focused production systems) require specific set of goals, to better reflect peculiarities of the environment. In turn, different set of goals should contextualize

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 278–285, 2022.
http://doi.org/10.1007/978-3-030-97947-8_37

the desired outcomes of lean initiatives. Ref. [30] states that the contextual factors of manufacturing environment might affect the relevance of lean, as HMLV manufacturers usually don't consider efficiency to be competing advantage, but are rather focused on flexibility. While there are articles reporting successful lean implementation [22, 23], their number is still limited compared to LMHV industry.

There have been many literature reviews on lean [19, 21, 28], but none with focus on HMLV industry, especially not on the outcomes of lean implementation in HMLV industry. Ref. [17] claims that exploring possibilities of lean implementation in low volume industries will become one of the key topics in future research. Systematic literature reviews are important in guiding future research endeavors, both in addressing new issues and old issues in new context (e.g. context of lean in HMLV industry), as they help building a coherent lean body of knowledge [10]. For this reason, we decided to investigate the outcomes of lean implementation with a specific focus on High-Mix/Low-Volume. For this purpose, a systematic literature review procedure was conducted, in order to analyze implementation reports from state-of-the-art literature. The remainder of the paper is organized as follows: Sect. 2 describes systematic literature review method used in this study. Section 3 presents the results of the analysis. Discussion of the results and directions for future research are presented in Sect. 4, followed by conclusion in Sect. 5.

2 Research Methodology – Systematic Literature Review

We started the research by asking 'what are the outcomes of lean implementation in HMLV industry?'. To answer this question, we followed the systematic literature review procedure, as proposed by Ref. [39].

2.1 Planning the Review

For this review, we used two abstract and citation databases, Scopus and Web of Science, as they are often used in literature reviews [2, 38]. We searched articles and articles in press to maintain high level of quality of the source material.

Two sets of keywords were used to capture heterogeneity of lean and HMLV industry. First set included the following keywords: 'lean', 'Toyota Production System', 'TPS', 'World Class Manufacturing', and 'WMC'. Second set considered HMLV industry, and consisted of following terms: 'job shop', 'make to order', 'engineer to order', 'high mix low volume', 'high variety', and 'non-repetitive'. The association rule for combining keywords from two sets was 'AND' (e.g. 'lean' AND 'job shop'). Search was restricted to title, abstract, and keywords of the paper.

2.2 Conducting a Review

The search yielded 267 articles. After removing duplicated and papers not relevant for the topic of this research, the sample was reduced to 123 articles, of which 104 could be retrieved. Snowballing procedure yielded 6 additional articles, added to sample, summing it up to 110 articles. Finally, from this sample we extracted articles that used case

study (single and multiple), field study, and action research as a research methodology. This reduced our final sample to 59 articles. All articles from the final sample were analyzed in detail. For each of the papers, following questions were asked: Is there a formal model for lean implementation? What are the outcomes of lean implementation? Are outcomes anecdotal of quantifiable? How are the outcomes achieved?

3 Results of the Literature Review

Out of 59 cases, 26 (44%) present a framework for lean implementation, all of them being verified in one or more HMLV companies. With 21 (36%) cases it is not explicitly clear what are the outcomes of lean implementation. Finally, 38 papers present outcomes of successful lean implementation, 28 of them quantifiable and 10 anecdotal. For the purpose of this study, the outcomes were divided into five categories: (i) time-related outcomes; (ii) cost-related outcomes; (iii) quality related outcomes; (iv) productivity-related outcomes; and (v) general waste-related outcomes. The distribution of outcomes in the sample is summarized in Fig. 1.

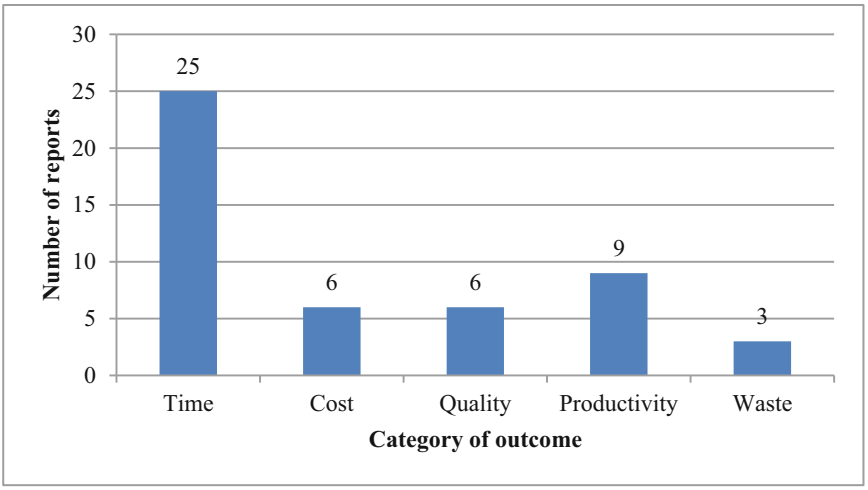

Fig. 1. Number of outcome reports per outcome category (Note that one case can report outcomes in several categories)

3.1 Time-Related Outcomes

Most cases report some sort of time-related outcome of lean implementation. Frequent time-related outcome is lead time reduction. This is expected, as short lead times are one of competitive advantages in HMLV industry. The results show reductions by as low as 17% [35], up to as high as 76% [5]. Value Stream Mapping (VSM) is commonly used as a diagnostic tool to identify potentials for lead time reduction. Lead time reduction

is mostly achieved through non-value added activities (NVA) removal [9, 14, 32, 35] or through implementation of pull system that effectively decreases the amount of work-in-process (WIP) [5, 31, 36]. As replenishment pull (e.g. Kanban) is hard to implement in HMLV industry [13, 23], authors often opt for simpler solutions more suitable for specific environment, e.g. CONWIP [5, 36]. Most lead time reduction efforts are focused on shop-floor, with only one report extending lead time reduction to entire internal supply chain [4]. Authors often assume that it is possible to identify product families, that cycle times and takt time are fairly constant, that product routings are fixed, which is often not possible in HMLV industry. Due date adherence and improved on-time delivery are also reported, usually as a consequence of a shorter lead time, as material flow becomes more transparent, throughput more predictable, and due date quoting more easy [4, 8], and the results can be significant [4, 33].

3.2 Cost-Related Outcomes

Out of 59 cases, 6 report some form of cost saving. Ref. [23] reports that cost savings are due to lower labor requirements, while other papers don't give the structure of cost savings [4, 6, 34]. Most cases report cost savings at around 10%. However, Ref. [4] shows that cost savings can be significantly higher (around 50%) if lean implementation efforts are distributed throughout entire internal supply chain, and not just shop-floor.

3.3 Quality-Related Outcomes

Ref. [23] states that quality if hard to embed in processes in HMLV industry, due to low repetitiveness which makes them hard to perfect. Authors claim that some quality improvements have been made, but it is not clear how they have been achieved. Ref. [4] also doesn't provide explicit quality improvement data, but states that after lean implementation quality cost was lowered to 1% of sale. Other authors report 10–30% reduction in defects, achieved through standardized work and NVA reduction [18, 32]. However, this approach requires product mix reduction to some extent.

3.4 Productivity-Related Outcomes

Higher productivity is usually reported as increased output [16, 26, 27] or lower labor costs [12, 23]. Higher levels of productivity are achieved through cell manufacturing [19, 20], line balancing that leads to greater resource utilization [26, 27], or assimilation to flow lines [12, 16]. It is interesting to note that propositions for productivity improvement effectively bring HMLV manufacturing closer to repetitive production systems, which in turn can be detrimental to flexibility. Ref. [18] reports 20% productivity increase, but doesn't elaborate further how productivity is calculated.

3.5 Waste-Related Outcomes

Only three cases report outcomes that are related to general waste reduction. Waste is defined in traditional terms, e.g. seven wastes [3, 29, 32], or activities that do not add

value to customers [11]. The results report reduced inventories, shorter transport, less waiting, and are mostly anecdotal. In addition, waste is analyzed without deeper contextual considerations, as things that are wasteful in LMHV industry can be considered asset in HMLV industry (e.g. excess capacity).

4 Discussion

Current research mostly shows positive side of lean, while inhibiting factors for lean outcomes remain unaddressed. This could be detrimental to lean implementation, as false conclusion can be drawn that every lean implementation in HMLV industry leads to positive outcomes. Most outcomes are in regard to efficiency, i.e. greater output with fewer resources. However, HMLV manufacturers often compete through flexibility, in order to meet frequent requirement changes from the customers. Consequently, high efficiency might not be as relevant as it is in LMHV industry [30]. In addition, efficiency usually requires some sort of specialization, which can negatively affect flexibility. This means that HMLV environment is often simplified and assimilated (usually by reducing product mix, or focusing on a very narrow set of products) to LMHV environment, making it more suitable for 'traditional' lean implementation. This simplification requires some assumptions that are often not feasible in HMLV industry (e.g. the existing of products families or relatively stable manufacturing environment) [25], and it neglects some important contextual factors, e.g. resource sharing and alternative routings [3]. This stresses the importance of considering a set of goals wisely, while reflecting on specificities of HMLV manufacturing environment [40]. This approach fully utilizes lean implementation potential, rather than copying implementation frameworks and desired outcomes from LMHV industry.

The results show that current research is focused on easily quantifiable outcomes, such as lead time, on-time delivery, and productivity. What current research vastly neglects are intermediate outcomes, such as employee engagement, better process understanding, teamwork, improved problem solving. In addition, little attention is given to customer satisfaction, and how it is affected by lean implementation.

Lean implementation in HMLV industry is case specific, and implementation frameworks used in literature propose different approaches with different combination of lean tools. This makes comparison difficult, as well as drawing the analogy between different lean implementation cases and their outcomes. Consequently, it is difficult to compare the outcomes themselves, and it is problematic to generalize causality and correlation between different lean practices and outcomes. In addition, most papers present results obtained through short-term case studies, making drawing conclusions regarding sustainability of outcomes over longer periods of time difficult.

Finally, most outcomes are a result of shop-floor related intervention. This is a shortcoming of existing literature, as other (transactional) processes present huge source of both inefficiency and ineffectiveness, as internal supply chain in HMLV industry can be highly complex [24, 37]. As waste propagates throughout internal supply chain, it would be favorable to explore how lean implementation outcomes from one stage of the internal supply chain affect the outcomes from subsequent stages (or how waste from one stage affects waste creation in other stages). In addition, integrative lean practices

implementation throughout the internal supply chain can enable better sustainability of the outcomes [4]. Based on the results of the review, and the discussion presented previously, we have summarized potential for future research regarding lean implementation outcomes in HMLV industry in Table 1.

Table 1. Directions for future research

Research topic	Current situation	Future research
Type of lean implementation outcome	Outcomes oriented towards efficiency	How can lean implementation affect flexibility in HMLV industry
	Lean implementation outcomes are easily quantifiable	Exploring intermediate goals of lean implementation, include customer satisfaction
	Goals emulated from LMHV environment	Exploring HMLV contextual factors when devising goals
How lean implementation outcomes are achieved	Case specific lean implementation which hinders generalization of outcomes	Theory based generalized frameworks that could facilitate outcome comparison
	Assimilation by changing context to resemble more LMHV environment	Lean implementation approach that fully recognizes contextual factors of HMLV industry
How are outcomes of lean implementation sustained	Outcomes support only positive side of lean	Exploring the inhibitors that could affect the outcomes
	Short-term case studies, difficult to assess sustainability	Longitudinal case studies to corroborate sustainability of outcomes
	Focus on shop-floor	Extending lean implementation to entire internal supply chain

5 Conclusion

This study shows that the goals of lean implementation are modeled according to LMHV industry, while important HMLV contextual factors are neglected. The outcomes are predominantly efficiency related, while the impact of lean implementation on flexibility is disregarded. The outcomes show positive side of lean, are easily quantifiable, and often achieved through some sort of assimilation, while intermediate outcomes and outcomes in regard to customer satisfaction are not reported. There's little evidence of sustainability of lean implementation outcomes, as results are usually tracked over a short period of time. Possibilities for future research include exploring contextual factors when considering lean implementation and desired outcomes, extending the implementation to entire internal supply chain, analyzing outcome inhibitors, and longitudinal studies to corroborate sustainability of the outcomes.

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Evaluation of the Complexity of Cognitive-Oriented Tasks in Planned Maintenance Procedures

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Abstract. A core aspect of Industry 4.0 (I4.0) is the continuous communication between humans, machines and products enabled by cyber-physical production systems. The high complexity of tasks to be processed require an increasing cognitive effort. Under this perspective, the maintenance procedures are changing. Maintenances activities in I4.0 context can be considered as complex decision-making processes where the best option to solve problems is strongly affected by the capacity of the operator to quickly process the given information. The purpose of the paper consists to evaluate the complexity of cognitive-oriented tasks that must be performed by operators in planned maintenance procedures. At this scope, the joint adoption of the TACOM measure and the graph theory is pursued. The proposed methodology is tested on different planned maintenance procedures related to automotive and mechanical production sectors. The results showed a strong correlation between graph structures in terms of both the number of events and links, and the cognitive demand required for the information processing.

Keywords: Decision-making · Mental workload · Maintenance procedure · Task complexity

1 Introduction

Maintenance in Industry 4.0 plays a strategic role through programming, control and intervention activities that are related to the performance of industrial production systems. The digitalization of processes within Industry 4.0 gives innovative solutions and ways to manage critical business issues. Augmented reality (AR), for example, can be used to provide to maintenance operators a technical assistance service to be used during intervention activities [1]. The phenomenon of technological development in the field of maintenance is characterized by a zero-fault production in which an attempt is made to reduce the number of interventions to a minimum, with a view to autonomous production [2]. In highly automated industrial companies, the focus has moved from physical to cognitive tasks: operators are in fact strongly required to be flexible and able

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 286–293, 2022.
http://doi.org/10.1007/978-3-030-97947-8_38

to adapt to changes in the external environment [3]. The human factor is a key driver in the maintenance system: the operators are the real decision-makers and problem-solvers [4]. Operators face with complex scenarios in which they are required to identify the causes of failure in time and to take the right actions to solve the fault. The assessment of decision-making alternatives is linked to the ability of operators to process the information provided. Industrial procedures are the components that provide operators with the information needed to solve a problem. The variability of maintenance actions requires operators to make a cognitive effort [5]. The purpose of the paper is to evaluate the complexity of tasks of maintenance procedures through Task Complexity measure (TACOM) [6] and graph theory. The paper is structured as follows: the literature review is explained in Sect. 2; the numerical simulation with results are provided and discussed in Sect. 3; finally the conclusions are presented in Sect. 4.

2 Literature Review

2.1 Mental Workload of Operators in Decision-Making

Industry 4.0 defines a clear trend in increasing the productivity of Industrial Systems by the joint adoption of technological and human paradigms. In this context, the real challenge lies in the effective use of technology and therefore in the ability to have a workforce capable of acting promptly based on the use of computer tools, analysis and data processing capabilities. The interaction and execution of complex operations require a high cognitive demand for operators based on the understanding of data, reasoning and the ability to choose the best option during decision-making processes [7, 8]. The complexity of tasks has a direct effect on the mental workload and the perception of risk. Salvendy defines the mental workload as the exhaustion of internal human resources that are necessary to carry out a working activity [9]. In maintenance, many errors are caused by tasks that are too complex to perform, inadequate maintenance procedures or inappropriate training and experience of operators. The process of troubleshooting a fault is classified as a highly cognitive process as it requires operators to have multidisciplinary skills, high training and a suitable capacity of analysis and action [10, 11]. The evaluation of different decision-making alternatives during the execution of maintenance procedures, depends on the human ability to judge the different options and to make the most appropriate choice. Therefore, the real difficulty consists of the ability to support the operator during the decision-making process. The definition of the set of actions and the sequence of activities to be performed throughout the production process is functional to outline the operational framework.

2.2 Assessment of Maintenance Procedures Through Graph Theory and Task Complexity

The assessment of the complexity of tasks of maintenance procedures is the purpose of this study. Understanding the workload required by operators to perform maintenance tasks, allows to understand whether they are suitable to execute tasks in the right way and time. More complex the task is, more alternatives operators will have to analyse. The

effectiveness of maintenance teams willing to solve a particular problem is related to the amount of information provided and the ability of operators to process instructions [12]. Procedures in the business environment provide operators the set of tasks to be implemented for a given plant, machine or component. In the literature it is reported that operators in carrying out maintenance activities take between 15% and 30% of the total intervention time to search information for decision-making processes [13]. The availability of maintenance procedures therefore has a direct impact on downtime and consequently on the total efficiency of the production system. For this reason, it is necessary to provide ways of accomplishing tasks in a structured manner that is appropriate to the task that the operator is called to perform. Sharing data and experience related to the operation of equipment would make the execution of tasks easier from the cognitive perspective [1, 2, 14]. A maintenance procedure can be represented through graph theory. The graph is a useful tool to diagram the succession of activities for the performance of a task. In particular, thanks to the graphic representation of a procedure, it is possible to evaluate the level of complexity of operations and the number of decisional alternatives that operators have to analyse in decision-making processes [12]. To evaluate the information content of an arbitrary network, some researchers rely on the metric properties of graphs, others explain the relationship between information content and entropy through information-theoretic measures [15]. In general, each graph can be used to characterize a set of information according to Shannon's abstract definition [16–18].

The TACOM measure evaluates the complexity of the task in the implementation of guided procedures with an analytical method that uses the concept of Shannon entropy on graph [19] and it is expressed in bit unit as it is based on the graph entropy [17]. The TACOM value is based on five sub-measures that are necessary to quantify the task complexity of operating procedures. The five factors are calculated through the definition of entropy of a graph [20]. Step Information Complexity (SIC) explains the complexity of tasks based on the amount of information which must be processed during operations. Step Logic Complexity (SLC) and Step Size Complexity (SSC) evaluate the complexity of tasks through the number and sequence of actions that operators must be performed. Finally, Abstraction Hierarchy Complexity (AHC) and Engineering Decision Complexity (EDC) express the knowledge and cognitive resources that operators need during the execution of tasks. The five sub-measure are related to the concept of first and second order entropy. The first, defined as chromatic information content, provides information about the regularity of a graph: nodes that have the same number of in-degree and out-degree arrows belong to the same class. The second explains the structural information content by defining the amount of information useful to understand the graph; nodes that have the same neighbors nodes belong to the same class. These five sub-measures, were found to be mutually dependent. For this reason, they have been reorganized in order to refer to independent factors [21]. The reorganization defines three new complexity dimensions needed to assess the task complexity model: Task scope (TS), Task Structurability (TR) and Task Uncertainty (TU). In particular. Task Scope (TS) summarizes the concepts expressed by SSC and SIC, Task Structurability (TR) is linked to AHC and SLC and Task Uncertainty (TU) depends on the decision-making process (EDC sub-measure). The three dimensions are shown below [22]:

$$Task\ Scope\ (TS) = 0{,}716\,SIC + 0{,}284\,SSC \tag{1}$$

$$Task\ Structure\ (TR) = 0{,}891\,SLC + 0{,}109\,AHC \tag{2}$$

$$Task\ Uncertainty\ (TU) = EDC \tag{3}$$

The TACOM measure derives from information theory and can be applied to various contexts in which it is essential to examine the complexity of procedure-guided tasks [23, 24]. So, the methodological structure of TACOM is suitable to evaluate the complexity of tasks also in maintenance. The analysis of the study carried out highlights how the TACOM measure can be used in maintenance procedures to understand the level of complexity of maintenance operations.

3 TACOM for Maintenance Procedures: Numerical Examples

The supervision of industrial processes and the processing of a complex set of data requires a certain level of cognitive workload from maintenance operators. Starting from data sheet and control panels, operators execute tasks and solve problems on the basis of maintenance procedures. Identifying the relationship between the cause of the failure and the effect, intended as corrective action to be implemented, is useful to support operators' decisions in the execution of maintenance tasks. Procedures are the key element to assess the level of information and complexity of maintenance operations. This section examines the complexity of tasks in the application of guided procedures by applying the concepts of graph theory and TACOM to eight different maintenance procedures related to the automotive and mechanical production sector. Indeed, the process of troubleshooting a fault is classified as a highly cognitive process as it requires operators to have multidisciplinary skills, high training and a high capacity of analysis and action. The set of maintenance procedures are classified into short (5 min), medium (30 min) and long (60 and 120 min) according to the standard completion time required. Table 1 shows the number of nodes characterizing the graph structure, the values of SLC, SSC, the standard execution times in minutes and the calculated TACOM values of the set of eight maintenance procedures. In particular, SLC and SSC are based on the first and second order entropy concepts respectively [24]. As an example, the analytical expression of the SLC and SSC parameters for procedure 1 is reported in (4).

$$\begin{aligned} SLC &= -\left\{\frac{1}{8}log_2\left(\frac{1}{8}\right) + \frac{4}{8}log_2\left(\frac{4}{8}\right) + \frac{2}{8}log_2\left(\frac{2}{8}\right) + \frac{1}{8}log_2\left(\frac{1}{8}\right)\right\} = 1.75\ [bit] \\ SSC &= -\left\{8\frac{1}{8}log_2\left(\frac{1}{8}\right)\right\} = 3\ [bit] \end{aligned} \tag{4}$$

Table 1. Number of nodes, SLC, SSC, Execution Time, TACOM value of maintenance procedures

Procedure	Nodes	SLC [bit]	SSC [bit]	Execution time [min.]	TACOM [bit]
1	8	1.75	3	5	3.433
2	10	1.57	3.32	5	3.696
3	11	1.86	3.46	5	3.856
4	19	1.70	4.13	30	4.428
5	28	1.78	4.42	30	4.687
6	24	1.72	4.59	60	4.835
7	39	2.17	4.77	60	5.041
8	25	1.81	4.64	120	4.889

The set of actions to be processed within the procedure can be schematized in a graph in which the value of the Step Logic Complexity (SLC) and Step Size Complexity (SSC) increases with the complexity of the task. A more complex procedure requires a greater effort of the maintenance operator for the correct execution of tasks in the decision-making process. Procedures with a higher number of nodes and decision-making alternatives are characterized by higher values of the SLC and SSC parameters. The variability depends on the number and quality of information provided to the operator through the description of the activities in the maintenance procedure. The number of instructions has a direct impact on the choices that operator makes in relation to the number of alternatives presented at each decision node. More the information provided, less the operator's uncertainty in carrying out the task.

The definition of the five sub-measures is necessary to establish the corresponding value of TACOM, which makes it possible to assess the complexity of tasks to be performed by maintenance operators in the application of the eight maintenance procedures. Applying relations (1), (2) and (3) to the procedure 1, the following values are obtained: Task Scope (TS) = 3.778 [bit]; Task Structure (TR) = 1.987 [bit]; Task Uncertainty (TU) = 3.76 [bit]. The TACOM measure for each task can be calculated as follow (5) [22]; the results are shown in Table 1:

$$TACOM = \sqrt[2]{0.621 * TS^2 + 0.239 * TR^2 + 0.14 * TU^2}\ [bit] \tag{5}$$

SLC and SSC are the reference values for the calculation of the parameters Step Information Complexity (SIC), Abstraction Hierarchy Complexity (AHC) and Engineering Decision Complexity (EDC). By a regression analysis based on data available in [6], these values are correlated to SSC sub-measure by the following expressions:

$$Step\ Information\ Complexity\ (SIC) = 1.0249\,SSC + 1.0111\ [bit] \tag{6}$$

$$Abstraction\ Hierarchy\ Complexity\ (AHC) = 1.0921\,SSC + 0.65\ [bit] \tag{7}$$

$$Engineering\ Decision\ Complexity\ (EDC) = 1.0804\,SSC + 0.5193\ [bit] \tag{8}$$

The results show that as the number of nodes increases, there is an increase in the value of TACOM and therefore in the complexity of the cognitive tasks, as shown in Fig. 1 where procedures are ordered according to the increasing Execution Time. In fact, in a cognitive task, as the number of actions to be performed (SSC) and the amount of information and data to be processed (SIC) increase, the operator's knowledge domain (AHC) and the amount of cognitive resources required (EDC) increase in order to identify an appropriate choice criterion.

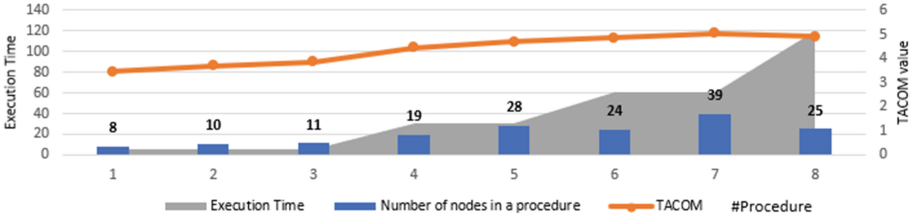

Fig. 1. Execution time, Number of nodes, and TACOM values of maintenance procedures

The number of nodes and links characterizing the graph structure provide indirectly information about the complexity of the tasks. As the number of actions and decisions that need to be made increases, the cognitive load of the operator increases. The number of alternatives to be analysed is therefore influenced by the amount of information and data provided to operators. By comparing procedures that require the same execution time, this growing trend can be seen. For example, procedure 6 and procedure 7 require an execution time of 60 min, but the cognitive effort required from the operator is different. In particular, procedure 6 describes a maintenance procedure for replacing a shaft motor while procedure 7 defines the instructions for replacing the reed valve. The number of nodes that composes the graph of the two procedures is respectively 24 and 39. The corresponding TACOM values are 4.835 and 5.041 [bit]. This difference in the TACOM value is due to the type of information provided in the two maintenance procedures and to the number of alternatives that the operator has to evaluate during the decision-making process. If procedures provide operators with exhaustive and detailed information, the decision-making process is well known and therefore a minor number of actions is required for the execution of the task. This situation corresponds to lower TACOM values. On the contrary, if the procedure provides less information, the operator has more problems in performing the activities and the TACOM value is higher. The absence of detailed information causes uncertainty for the operator in order to accomplish that task. This complexity is caused by the increasing number of scenarios that need to be evaluated for the correct execution of the task. In this context the graph structure is more asymmetric and composed by a larger number of nodes and connections. The greater the graph asymmetry is, the greater the number of classes to be considered in terms of second-order entropy [19], the greater is the cognitive effort required.

4 Conclusions

The role of the smart operator in the context of Industry 4.0 has evolved due to the increasing technological development. The correct execution of tasks is increasingly based on the ability of operators to analyse different scenarios through the analysis and processing of data provided by the system. Cognitive aspects are the new protagonists of the decision-making process that has a direct influence on the reliability of the industrial system and on the number of human errors. In order to assess the complexity of the decision-making process, attention has been paid to procedures which are the elements that provide maintenance operators with the necessary guidelines to carry out the various tasks (machine failures or anomalies). The present work quantified the complexity of tasks in the application of a set of maintenance procedures by using graph theory and the concept of entropy to quantify the task complexity with the TACOM measure. The results show that TACOM is an effective tool to evaluate the complexity of tasks in the maintenance field. The numerical examples highlight the variability of the complexity of tasks by comparing the TACOM values of maintenance procedures for automotive and mechanical production sector. In order to understand if human resources are correctly allocated in the system, it is necessary to estimate the level of complexity of tasks in the application of a procedure. The correct execution of a task in the decision-making process will depend on the cognitive capacity of human operator to process the information provided. Future research should focus in quantifying the cognitive resources of operators based on specific parameters such as age and experience.

Acknowledgement. This research work is part of the activities carried out in the context of the SO4SIMS project (Smart Operators 4.0 based on Simulation for Industry and Manufacturing Systems) funded by the Italian Ministry of Education, Universities and Research MIUR (Project PRIN – 2017FW8BB4).

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A Procedural Model for Utilizing Case-Based Reasoning in After-Sales Management

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Abstract. The identification of spare parts as an integral part of maintenance processes especially in mechanical and plant engineering requires expert knowledge. The main reason is an undeniable information gap in existing service documentations. Knowledge-based approaches may facilitate and ensure standardized management of service kits. This paper introduces an integrated procedural model deploying case-based reasoning (CBR) to document expert knowledge, and to automatize spare parts identification processes. The application of the procedural model is exemplified in an industrial use case, which deepens insights into the case derivation and solution generation steps using necessary similarity measures and related algorithms.

Keywords: Case-based reasoning · Service kit · Maintenance · After-sales management · Original Equipment Manufacturer (OEM)

1 Introduction

The after-sales area of mechanical and plant engineering companies is a crucial part of their value chains [1]. The main reason for this is the much higher added value of an intangible service compared to that of a physical primary product [2, 3]. However, one of the main operational challenges in practice is the lack of insights into data derived from services and spare parts management [4]. The underlying reasons, inter alia, are i) the incomplete or missing service documentation with regard to maintenance activities carried out in the past and spare parts installed as well as ii) the lack of digital documentation of older systems such as former generations and editions [5, 6]. In addition, maintenance instructions are carried out generically for entire plant series, i.e. without specific reference to part numbers, in order to minimize the documentation efforts. The aforementioned causalities result in missing information, which should be handled by involving domain experts who provide corresponding experience and knowledge. Basically, spare parts experts create a "service kit" consisting of several spare parts for planned maintenance work from accessible information [5]. Service kits consist of up to several hundred parts, which complexifies manual configuration. Due to the dependency

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 294–301, 2022.
http://doi.org/10.1007/978-3-030-97947-8_39

on specific employee knowledge, the content of resulting service kits may differ from expert to expert.

This paper presents a knowledge-based procedural model incorporating case-based reasoning (CBR). The procedural model serves as a documentation engine for storing the expert knowledge linked to past cases, and thus establishes the basis for the configuration of future service kits, i.e. deriving solution from formerly validated solution. This approach reduces spare part identification times, relieves the experts and ensures consistent service kit contents. The proposed process model has been developed, based on a real use case at a gas engine manufacturer in Austria. It is worth noting that this paper is briefly discusses the core model and the procedural approach without diving into the underlying mathematical models. The rest of the paper is structured as follows. Following the introduction in Sect. 1, a brief overview of the state-of-the-art is presented in Sect. 2. In Sect. 3, the procedural model is introduced, and an exemplified use case is discussed. Finally, Sect. 4 concludes the discussion and identifies further research pathways.

2 Literature Review

There are several approaches in the body of literature in maintenance and service management that are dedicated to the "repair kit problem" (RKP). The term "repair kit" is used by the investigated approaches to describe the stock of spare parts in a technician's service vehicle for the repair of small electrical appliances. The availability of a repair kit leads to a trade-off between "holding costs" and "return-to-fit costs", which arise when spare parts are missing. The cost optimization methods of the RKP-approaches are mainly based on heuristics as illustrated in the reviewed literature, cf. [7–17].

The approach presented in [18] considers a "service kit" as a predefined collection of parts and tools for a medical intervention, which is kept in a central storage area in a "transaction-orientated" manner, i.e. oriented towards a specific type of surgery. This approach focuses exclusively on the optimization of warehousing costs, and thus does not include a definition or identification of the correct components of the service kit. The kitting approach according to [19] examines the service kit generation from a customer perspective in the field of mechanical and plant engineering. In this approach, the term "service kit" describes the spare parts stock on the customer side for different plants. Notably, this approach integrates a manual test step by a spare parts expert.

According to the literature CBR is an approach to utilize the specific knowledge of previously experienced, concrete problem situations (cases) [27]. The successful application of CBR in the context of maintenance is evidenced by several approaches. Notable examples are i) optimizing the service and repair of motor vehicles [20], ii) the diagnosis of vehicle engine faults [21], iii) knowledge management of plant drive units by means of graph-based reasoning [22], iv) maintenance optimization of machine tools and overhead cranes [23, 24], and v) determining the expected maintenance time [25]. These approaches are partly based in the field of mechanical and plant engineering and mainly focus on the maintenance measure "Overhaul" (cf. DIN 31051 [26]) rather than creation of service kits. The abovementioned approaches are analyzed based on the requirements for designing a procedural model gaining benefits from CBR, as depicted in Table 1.

Evidently, the analysis reveals the existing gap and the demand to further explore using CBR approaches in after-sales management.

Table 1. Literature analysis for using in CBR in after-sales management

Literature / Requirements of procedural model		Approach is designed for mechanical- and plant engineering	Approach is designed from a manufacturers perspective	Approach delivers machinery specific service kits	Approach focuses on maintenance work or overhaul	Approach focuses on spare parts identification process	Approach is using case-based Reasoning
Year	Author						
Repair kit problem approaches							
1980	Smith et al.	○	●	○	●	○	○
1982	Graves et al.	○	●	○	●	○	○
1982	Hausman	○	●	○	●	○	○
1982	Mamer and Smith	○	●	○	●	○	○
1984	March and Scudder	○	●	○	●	○	○
1993	Brunelle and Granot	○	●	○	●	○	○
1994	Heeremans and Gelders	○	●	○	●	○	○
2006	Teunter	○	●	○	●	○	○
2010	Bijvank et al.	○	●	○	●	○	○
2017	Saccani et al.	○	●	○	●	○	○
2017	Prak et al.	○	●	○	●	○	○
Other kitting approaches							
2013	Güllü and Köksalan	○	○	◗	◗	○	○
2015	Moharana and Sarmah	●	○	●	●	◗	○
CBR approaches							
2011	Chougule et al.	○	●	○	●	○	●
2011	Vong et al.	○	●	○	●	○	●
2013	Kamsu-Foguem and Noyes	●	●	○	●	○	●
2013	Potes Ruiz et al.	●	●	○	●	○	●
2014	Potes Ruiz et al.	●	●	○	●	○	●
2017	Mourtzis et al.	●	●	○	●	○	●
Presented procedural model		●	●	●	●	●	●

Degree of fulfillment: ● = entirely ◗ = partly ○ = not

3 Procedural Model for Knowledge-Based Service-Kit Generation

3.1 Spare Parts Identification Process

The identification of spare parts takes place in three phases. In phase 1 (P1), the maintenance instruction IDs (MN IDs) to be carried out are defined, based on a customer request. In phase 2 (P2), a spare part expert identifies the required spare parts by means of the identified MN IDs and the service bill of materials (SBOM). In phase 3 (P3),

the identified spare parts are checked for new available item versions (so called supersessions). P1 and P3 are carried out by rule-based methods. P2 is knowledge-based, i.e. the expert carries out three reasoning processes. In reasoning process 1 (I1), the required item descriptions (IDP) are identified by reading the maintenance instruction. In reasoning process 2 (I2), the expert searches for the IDP in the SBOM and notes the item number and item quantity noted there. To do this, the expert implicitly uses the tree structure of the multilevel SBOM. The expert knows in which assembly the IDP that he/she is looking for is located. During this process, the expert implicitly identifies the correct position of an item in the multilevel SBOM. The identification of the correct items is additionally ensured by comparing the IDP of the MN ID with the IDP of the SBOM. In reasoning process 3 (I3), the expert adds further IDPs, item numbers (ITN) and quantities (QTY), based on his/her personal experience and knowledge. These parts are required for the implementation but are not noted in the MN IDs, due to existing information gaps. The expert, therefore, formally answers the following questions: (a) Which ITN of which position numbers (PON) of the SBOM are required for the execution of the required MN ID and in which QTY? (b) Which supersession item numbers of which PON of the SBOM and in what QTY are required in addition to the specifications of each MN ID? (c) Do the IDPs listed on the identified PONs of the SBOM correspond to the required IDPs from the existing MN IDs?

3.2 Integration of CBR in the Procedural Model

The CBR cycle represents a generally valid process model which consists of the for main steps i) retrieve, ii) reuse, iii) revise and iv) retain a case from/to the case base [27]. The developed process model, as illustrated in Fig. 1, integrates P1-P3 into an overall system and contains a formal description of the individual steps for their automated execution. The execution of P2 is based on the CBR cycle, which formally describes and stores the described expert knowledge in cases and ensures their reusability. In particular, **P1** contains the preprocessing steps for the formulation of the CBR problem in step 5. In step 1, the relevant attributes of the received service request are extracted. These include *(a1) unit ID*, *(a2) unit type ID* and *(a3) actual operating hours*. These attributes are used to identify the valid maintenance schedule (MS) in step 2, the relevant maintenance interval (MI) in step 3 and the MN IDs to be performed in step 4. **In P2,** step 5 generates the query problem for the CBR mechanism. This consists of the attributes *(a2) unit type ID*, *(a4) MN ID, (a5) ITN* of the SBOM and *(a6) IDP* of the SBOM. The cases stored in the case base are structured in sub-case bases for each MN ID. If several MN IDs are required to perform an MI, the respective query problem is assigned to a sub-case base in step 6. In step 7, the attribute *a2* of the query problem is compared with the stored cases to determine their suitability in principle. Step 8 checks whether the PON stored in a case exists in the present SBOM. If they are present, step 9 checks the similarity between the IDP of the present problem and the stored case. Step 10 calculates the overall similarity based on the similarities from steps 7–9. Steps 5–10 are repetitive for each MN ID. In step 11 the total similarities of step 10 are integrated to a global similarity. Steps 5–11 are assigned to the main process “retrieve” of the general CBR mechanism. The solution of the best fitting case per MN ID is carried out in step 12, where the ITNs and QTYs on the individual PON are selected. A manual check of the results and, if necessary, a

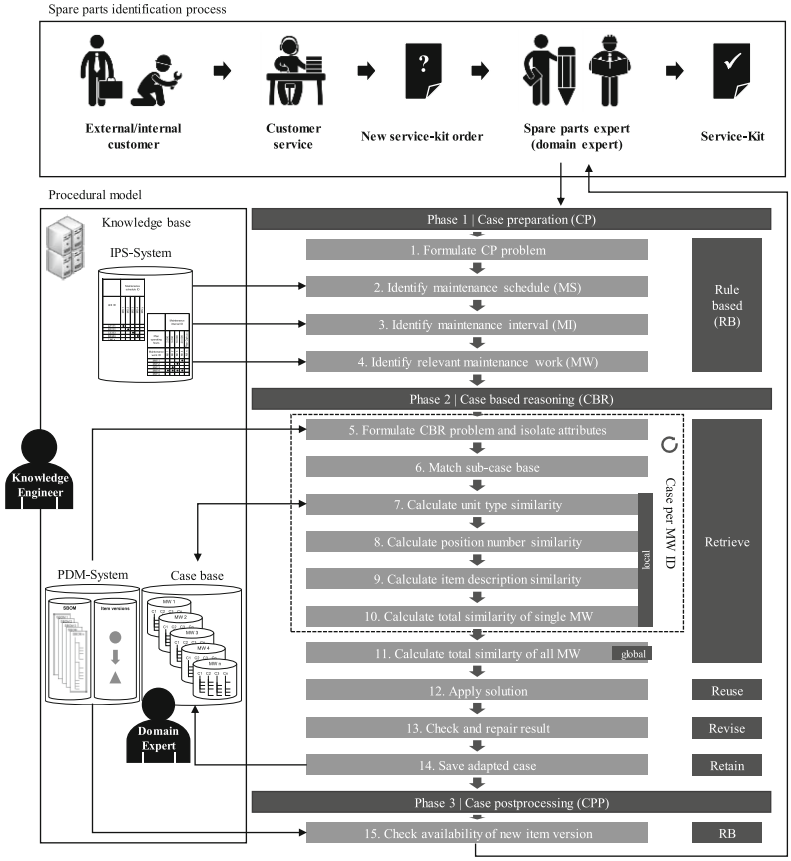

Fig. 1. Linkage of procedural model and spare parts identification process

correction by the spare parts expert is carried out in step 13. If corrections were made to individual PONs for a MN ID, they are stored in the case base in step 14 as a new case. Step 14 marks the last step of the CBR cycle. **In P3**, the identified ITNs are checked for possible supersession item numbers in step 15. Old ITNs may be listed in the SBOM but may be obsolete due to new engineering developments. Analogous to the steps of phase 1, this step is rule-based. The result of the steps 1–15 is a list of ITNs, IDPs and QTYs which are required for the execution of the MI identified in step 3. This list is called "service kit".

3.3 Instantiation of the Procedural Model in the Gas Engine Manufacturing

The following use case, taken from the study conducted in the context of gas engine manufacturing, describes the core steps 5–10 of the presented procedural model in Fig. 1. Figure 2 exemplifies i) creation of a new case (Example 1), and ii) application of a case from the case base (Example 2). In example 1, steps 1–4 of the procedural model are

performed for the incoming service order. This results in the MN ID = W2711 to be performed for the exchange of elastomer parts.

The spare parts expert extracts the IDPs of the relevant items from the texts and contents of the MN ID. Since the MN ID is valid for an entire series with several variants, no specific ITN can be taken from the document. In the next step, the spare parts expert uses his/her experience to identify the PON on which the required IDPs are located. In the example, the *IDP = O-ring* on *PON = 10-10-30* is identified with the *ITN = 1990* and the *QTY = 8* for the *Unit ID = A1946*, and the *IDP = Gasket* on *PON = 10-10-40* with *ITN = 1953* and the *QTY = 2*.

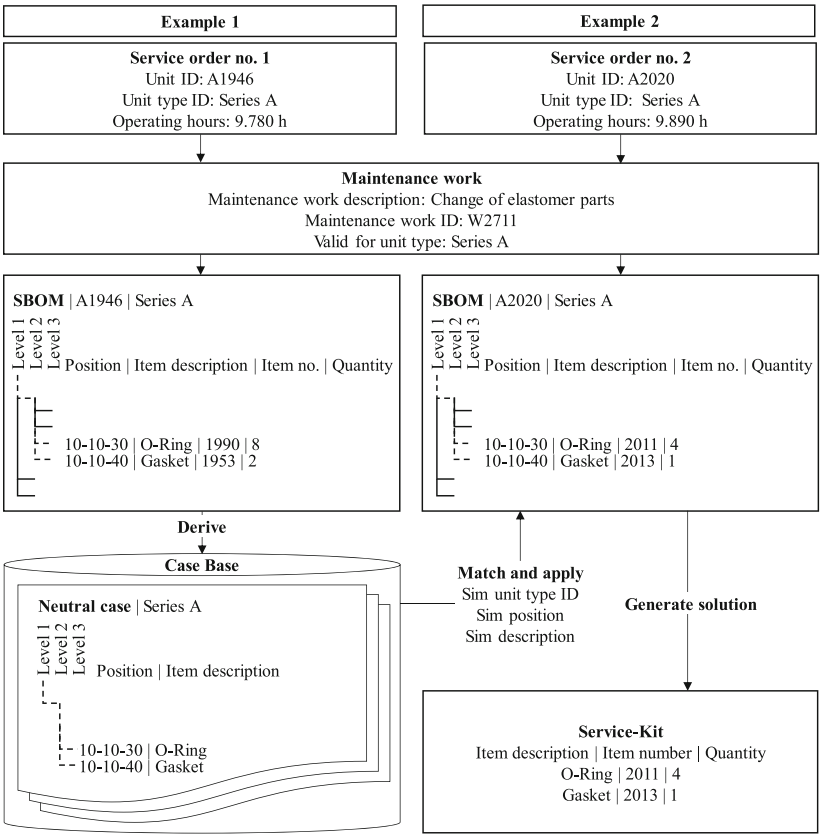

Fig. 2. Example for case derivation and solution generation

In the following, the applied expert knowledge can be described neutrally as a case. In a comparable system with a similar configuration, the parts with the *IDP = O-ring* and *IDP = Gasket* should also be located on the *PON = 10-10-30* and *PON = 10-10-40*. The derived case is, therefore, described with the attributes *unit type ID*, *PON* and *IDP*. The attribute *unit type ID* can only occur once in each case. The number of other attributes is variable depending on the number of parts required. Similar to example 1, the steps 1–4

in example 2 with the *unit ID* = *A2020* also result in the *MN ID* = *W2711* to be carried out. To reduce the search effort in the SBOM, appropriate solutions stored in the case base can be used. Using the similarity measure *sim unit type ID*, all cases with a match of the attribute *unit type ID* are identified.

With the similarity measure *sim PON* the SBOM and the stored case are analyzed for identical PONs. With the similarity measure *sim IDP*, the expected *IDP* of the stored case is compared with the *IDP* of the SBOM. If there are appropriate matchings the ITN and QTY will be taken from the positively evaluated PONs. In example 2, the service kit results from the parts with *IDP* = *O-ring* from *PON* = *10–10-30* with *ITN* = *2011* and *QTY* = *4*, and *IDP* = *Gasket* from. *PON* = *10–10-40* with *ITN* = *2013* and *QTY* = *1*.

4 Conclusion and Outlook

This present approach examine how expert knowledge in the context of spare parts identification in mechanical and plant engineering can be described in a formalized way. Gaining advantage of CBR, expert knowledge can be stored and reused sustainably in future identification processes. Thus, cycle times and experts' workload can be reduced. Beside further evaluation of the proposed approach in various industrial use-cases, future research work will focus on elaborating the retrieve mechanism in course of the CBR cycle as well as on developing and structuring the case base in industrial context.

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On the Technical Debt Prioritization and Cost Estimation with SonarQube Tool

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Abstract. Commonly, software developers are faced with situations to compromise internal quality to achieve short term goals, e.g. time-to-market. In software engineering, such compromises are described with Technical Debt (TD) concept. TD implies cost of additional rework—usually expressed as effort—and when the code is compromised, it is called code debt. One of the most popular tools for identifying TD items and estimating effort for solving them is SonarQube. However, there is still a need for empirical validations of remediation times that SonarQube estimates. The objective of this research is to validate the usefulness of the tool for novice developers in terms of understanding SonarQube's categorization of criticality levels of TD issues and accuracy of estimated remediation times. We designed and conducted an empirical study with 185 students in a context of university software engineering courses in Finland and Serbia. The estimates provided by SonarQube are more pessimistic, i.e. only in 3% of cases the actual fixing time was higher that the estimated one. Our results also indicate that participants' perception of the criticality levels of the TD items is misaligned with SonarQube's classification and prioritization.

Keywords: Technical debt · Empirical study · Technical debt management · SonarQube

1 Introduction

Commonly, software developers are faced with situations to compromise internal quality to achieve short term goals, e.g. time-to-market. In software engineering, such compromises are described with Technical Debt (TD) concept [1]. TD implies cost of additional rework—usually expressed as effort—and when the code is compromised, it is called code debt [14].

The first mention of the concept TD is related to late 90's by Cunningham, who defined TD as a metaphor that will help to make some aspects of internal software quality visible [10, 13]. TD contextualizes the problem of outstanding work in software development tasks (e.g. pending refactoring) as a debt that provides short-term benefits in software development that will be paid much harder in the later stages of development

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 302–309, 2022.
http://doi.org/10.1007/978-3-030-97947-8_40

[1, 14]. The debt metaphor reminds developers about the choices that can be made with design flaws [3].

The concept of TD can be particularly useful when used by junior developers, who nowadays represent the large majority of developers. However, some empirical investigations indicate that junior developers are less familiar with the concept of TD than their more experienced colleagues [11, 20].

Different Automated Static Analysis Tools (ASAT) can be used to identify TD [2]. SonarQube (SQ)[1]was one of the first ASAT tools that provides estimates of the accumulated TD in source code. It is done by applying different code metrics and meeting a large number of coding rules that are defined for different programming languages [8].

In this research, we aim to determine how accurate SQ's time estimates are when used by junior developers, as well as whether their perception of TD issues criticality matches SQ's categorization. For this purpose, we designed and conducted an empirical study with 185 junior developers in academic setting.

Results of this study can be of interest to industry practitioners who are planning to adopt the SQ on their software projects to better interpret estimated remediation times, especially when remediation tasks are assigned to junior developers.

This paper is structured as follows. Section 2 presents a literature review on this topic. Section 3 describes the empirical design of the research. Section 4 presents the results obtained by the research. Section 5 identifies the threats to the validity of this paper and Sect. 6 defines the conclusion and future work.

2 Related Work

In this section we introduce all relevant aspects of the SonarQube for this study, alongside with an overview of the literature regarding empirical investigations of TD estimations with SQ. There are not many contributions on the topic of the use of different ASAT tools for improving the quality of developers work.

2.1 SonarQube

SQ identifies three basic types of TD issues. (1) **Code smells** are points in the code that can be difficult to maintain. Also, issues can be classified as security (2) **Vulnerabilities** or (3) **Bugs** that will cause the breaking of code. After identifying an issue, SQ estimates *remediation effort* or the time needed to remove that issue [9].

SQ provides users with categorization of identified issues according to the level of critically at five categories [15]. *Blocker* represents most critical level of SQ issue for bugs with a high probability to affect program misbehavior. *Critical* are issues that represents bugs with low probability to impact the program or a major security flow. *Major*are problems that can significantly affect the productivity of developers. *Minor*are issues that have minimal impact on productivity [15]. *Info* is issue that provides information to developers [15].

[1] https://www.sonarqube.org/.

2.2 Empirical Investigations of TD Estimates

The first empirical papers on the topic of TD identification using the SQ tool were written in the mid 2010s when SQ began to be used [4, 10]. The papers mainly focused on improving the metrics and rules used by SQ. Characteristically, research has been done on open-source projects. [4, 18, 19].

Researches in 2019 and 2020 is aimed at improving the list of SQ rules [5, 8, 9, 12]. During these years, the papers have been extended to academic purposes, which includes students as the main respondents [9, 12]. Machine Learning is introduced as one of the solutions to emerge improving performance (e.g. use of SZZ algorithm) [8].

Some papers are also focused on estimating the time to solve the identified SQ issues. The researches have come to the conclusion that SQ gives overestimated remediation times and that the percentage of accurate estimates is even less than 20 percent. That can easily affect inexperienced developers productivity [5, 6, 16].

This research is focused on the time estimate provided by SQ and prioritization of SQ issues which is very interesting topic that no specific research has yet been done as far as we know.

3 Study Design

In this section, we present the research question that are the main focus of this paper, protocol for data collecting, and execution of the study.

3.1 Research Questions

RQ1. How Accurate are SQ's Remediation Times in the Case of Junior Developers? Answering this question should inform us what to expect when remediation tasks are assigned to junior developers with respect to the estimated effort, i.e. cost.

RQ2. How do Junior Developers Categorize Criticality of TD Issues Identified by SQ? This RQ investigates whether the perceived criticality of identified TD issues by junior developers alignes with SQ's criticality levels.

3.2 Data Collection

In this Section, we give an overview of the case study protocol, the selection of the participants, and the follow-up survey.

Case Study Protocol. The research was conducted in a context of university courses. As a part of the student assignments, i.e. projects, SQ was used as a tool for static code analysis. Students had to correct all generated issues and record the actual time required to resolve them. Upon the completion of assignments, a follow-up survey was conducted.

Subjects. We selected participants for the two replications from two University in the context of a software engineering courses. Students are divided into teams of six to eight people. Teams were formed in the following way. The first members of the teams were picked by instructors, afterward each picked member was instructed to pick one next member from remaining students until the groups are formed.

Follow-up Survey. The follow-up survey was in English and it contained a list of up to ten the most frequent TD issues that students had to evaluate the criticality for each issue in the survey. A four-point ordinal scale from *Not concerned at all* to *Very concerned* was offered for the answer to each question and each team was given a list of approximately ten issues that were most common in their project.

3.3 Execution of the Study

Authors from Finland conducted the research as a part of a course at Tampere University, while authors from Serbia conducted the research at the University of Novi Sad.

The Case Finland implied that each team of students participating in the research must select one Java open-source project. Further work is focused on the analysis performed by SQ and the correction of identified errors (e.g. refactoring). Students were instructed to use SQ (community Version 7.4 (build 18908)).

The Case Serbia meant that students divided into teams start the development of the project from scratch. The project assignments included a highlevel specification of an e-commerce system and instructions for the development process. The projects were done in C# programming language. Students were instructed to use the same version of SQ as in Finland.

3.4 Analysis and Interpretation

Analysis and Interpretation for RQ1. We collected actual remediation times from participants and calculated the following quantitative indicators to better describe differences between SQ's estimates and actual times. The usage of different indicators allows us to obtain a more complete picture of the estimation accuracy.

Mean(RE) is the mean of Relative Errors (REs), $Mean(RE) = \frac{1}{n}\sum_{i=1}^{n} RE_i$, where n represents the number of SQ's estimations, while RE_i is the RE of the i-th estimation. Relative error is defined as $RE_i = \frac{actual - estimate}{actual}$ for each i-th estimation [2]. This metric is useful to provide insight weather estimated values are on average larger than actual times, i.e. overestimated, and in that case the $sgn(MeanRE) = -1$; while for underestimated values$sgn\ (MeanRE) = +1$.

In order to better analyse the magnitude of the differences between actual times and estimated values by SQ we calculated *the mean magnitude of RE (MMRE)* and *the median magnitude of RE (MdMRE).*

MMRE is calculates as $MMRE = \frac{1}{n}\sum_{i=1}^{n} MRE_i$, where n represents the number of SQ's estimations, while $MRE_i$is the MRE of the i-th estimation. Magnitude of relative error is defined as $MRE_i = \frac{|actual - estimate|}{|actual|}$ for each i-th estimation [2]. If the value of *MMRE* is small, then we can say that SQ should give us on average good estimations.

MdMRE. The given *n* SQ's estimations, *MdMRE*is computed as the median of the MREs of estimations [7]. The lower the *MdMRE*value is, the better SQ's estimations are.

Analysis and Interpretation for RQ2. In order to assess the perceived criticality of TD issues by junior and novice developers we used the results of the follow-up survey. The criticality assessment of a TD issue was performed based on the response frequencies given by the students where all team members rated an identical group of TD issues.

Each TD issue that SQ identifies has a certain level of criticality, we used the following mapping between the responses from the survey and criticality levels. TD issues marked by Sonar as *Info* are considered as an issue that participants were *Not concerned at all*, *Minor* coincides with the answer from the survey *Not very concerned*, *Major* is equivalent to the answer *Concerned*, while *Blocker* and *Critical* correspond to *Very concerned*.

4 Results

In Case Finland, the study involved 133 students who were divided into teams of 4 to 6 members. We collected data from 26 different open-source projects which only 11 projects provided valid data. It Case Serbia, there were a total of 52 students divided into 6 teams and all of 6 projects provided valid data.

4.1 RQ1. How Accurate are SQ's Remediation Times in the Case of Junior Developers?

Table 1 shows the summary of the data analysis. The actual remediation times for the majority of TD items were significantly smaller than SQ estimates (the sign − 1 indicates overestimated values). Interestingly, overestimated values doesnot depend on the type of the issue nor on the criticality level. Only in the case of two blocker issues (Case Serbia), SQ estimates were smaller than actual.

Regarding the magnitude of the difference in the estimated and actual values, in Case Finland, the difference is significantly larger compared to Serbian data. A plausible reason for this is that in Serbia the projects were done from the scratch by students, while in Finland the students had the task to choose an open-source project whose scope is significantly larger.

Table 1. Relative error indicators for TD issue remediation times grouped by Type and Severity for Finland and Serbia Cases.

TD items		Finland				Serbia			
		N	*SGN*(·)	MmRE	MdMRE	*N*	*SGN*(·)	MmRE	MdMRE
Type	Bug	122	–	525%	495%	10	–	78%	78%
	Code smell	3703	–	456%	435%	475	–	70%	69%
	Vuln	1256	–	629%	650%	3	–	80%	80%
Severity	Minor	1557	–	378%	339%	153	–	76%	75%
	Major	1945	–	581%	584%	312	–	63%	63%
	Critical	465	–	472%	452%	21	–	69%	68%
	Blocker	58	–	436%	445%	2	+	70%	70%

4.2 RQ2. How do Junior Developers Categorize Criticality of TD Issues Identified by SQ?

Figure 1 depicts the results of the follow-up survey. Due to space limitation, here we present results for the top ten of the most frequent TD issues that occured.

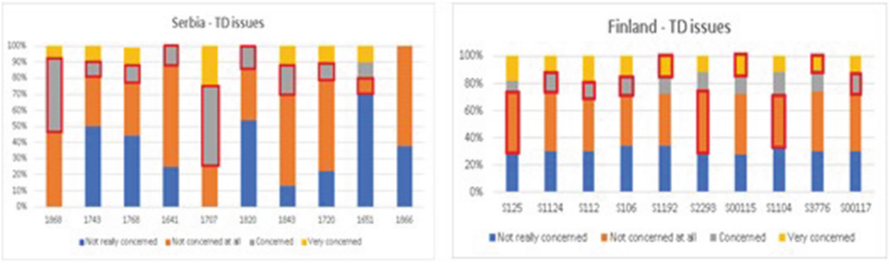

Fig. 1. Percived TD issue criticality level vs. SQ's categorization for the top-10 TD issues. Red-box indicate SQ's categorization for the given TD issue.

The red rectangle indicates the percentage of students whose perception of criticality coincides with SQ's assessment. The Fig. 1 shows that only in the case of 5 issues from both Cases around 40% of students rate the criticality level identical to SQ.

5 Threats to Validity

The empirical research presented in this paper is prone to validity issues that we tried to address.

Construct Validity: The main factor is socio-behavioral phenomena [17], which was reduced in the research by the fact that students did not even know that they were participating in the research, but performed all tasks within the project. As part of the follow-up survey, only the students were introduced to the goal of the research.

Conclusion Validity: The activity that could have undermined the success of the research was the erroneous entry of time by the students because they entered the time independently. However, each student received a large number of issues and the probability of disrupting the research is minimal.

Internal Validity: Instrumentation and maturation are two threats to internal validity [17]. Instrumentation, in our case the questionnaire is comprised of direct questions only, resulting with as minimal as possible interpretations. While maturation indicates that participants might act differently as time passes, which can happen if a questionnaire is too long [17].

External Validity: Threats to external validity limit the generalizability of the findings [17]. The focus of the research is on junior developers but we have achieved diversity in different project contexts and by having two comparative Cases.

6 Conclusion and Future Work

In this paper we presented results of an empirical study conducted in a context of two university courses in Finland and in Serbia.

The results indicated that SQ's remediation times to address TD issues are mostly greater than actual times reported by junior developers, i.e. SQ's cost estimates are higher. Such finding is unexpected because the focus group was junior developers who had minimal programming experience. Also, we found that SQ's categorization of the criticality levels is misaligned with participant's perception of the criticality levels.

Future work on this topic should be aimed at increasing the number of respondents so that the result can be generalized.

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Fundamentals of Integrated Risk Management Model in Business Processes

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Abstract. Methodologies for identifying and measuring inherent and residual risk already exist for business risk management and business process management. Existing methodologies are in most cases descriptive, and the descriptions are based on subjective knowledge of business processes and internal control systems.

If the focus of managers and internal auditors, in creating and controlling business processes, thanks to risk management, is shifted from the past and present, the integrated model values the impact of inherent risks and measures the impact of internal control systems on its reduction is projected into a realistic future. Although it requires additional engagement in the analysis and forecasting of the financial and yield position, as well as the implemented system of internal controls in the business processes of the entities. The integrated business risk management model is simple and economical in its application. The aim of this paper is to show that the application of this Model, among other things, achieves a strategic approach to business risk management in accordance with the adopted strategic plan of the entity, primarily through the analysis of management processes. The result of the work is the development of a model that could be applied in any company, regardless of the activity and ownership structure.

Keywords: Business process · Risk management · Model · Internal control

1 Introduction

Risk management is a very complex process which additionally requires a set of tools to be used within the model in order to manage business risks adequately. Risks are very often approached accidentally in the daily business routine, which leads to unnecessary and unplanned costs, which in turn reduces the organization's overall value. Failures caused by poor risk management damage the reputation of the organization, and the consequences can be more serious than the initial failure (loss of profit, loss of reputation, loss of market, etc.).

Risk is an inevitable part of any organization's business and is therefore an integral part of the quality management system (ISO 9001) [1]. Risk mitigation is a substantial challenge for the organization. When risks are identified in the right way, it is possible to take mitigation actions if a potential risk arises and ISO standards have great benefits for the organizations that introduced them. ISO 31000 helps organizations to develop a

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 310–317, 2022.
http://doi.org/10.1007/978-3-030-97947-8_41

risk management strategy, which can help them to effectively identify and reduce risk and achieve the set goals [2].

Risk management creates value for the organization not only by helping to identify potential threats to the business, but also by enabling the identification of potential opportunities. The ISO 31000 standard is intended for organizations of all types and sizes that face internal and external factors, as well as influences that bring them uncertainty regarding the achievement of set goals. However, these standards have certain shortcomings; they cannot express metrics, value impact on business, materiality that arises from inadequate risk assessment.

2 Integrated Business Risk Management Model

Risk management of an entity should be seen as a tool that allows the entity to seize opportunities to increase value. This paper focuses on strategic risk management, which implies applying the concept of integrated management of all business risks to which an entity is exposed with the goal to increase the owner´s wealth and market value of the company. The basic goals of any business can be achieved by effective and proactive risk management, by taking into account through the pros and cons of risk, i.e. anticipating risks as a threat to business goals, but also opportunity that needs to be seized.

The ISO 31000 risk management model is presented in three parts: principles, frameworks and processes [2]. In addition to these three parts, the model presented in the paper also has a part that includes materiality projected into the future. Namely, in addition to risk assessment, it also includes the amount of material loss, expressed in monetary units, which the company would suffer in case of risk occurrence. There is a special tool within the Model that measures the influence of the existing internal control system in terms of reducing inherent risk. Among the other things, the Model enables achieving a strategic approach to business risk management in accordance with the adopted strategic plan of the entity, primarily through the analysis of management processes. Although it requires additional engagement in terms of analyzing and forecasting the financial and return items, as well as the implemented system of internal controls in the organization's business processes, the Integrated Business Risk Management Model is simple and economical in its application.

According to the COSO ERM framework, integrated risk management of an entity is implemented by the executive board, management and all employees, it is implemented throughout the whole entity in accordance with the strategy, designed to identify potential events that may affect the entity, all these with the goal to achieve objectives [3]. According to the COSO ERM (2004) the framework principle of integrated risk management consists of eight interconnected components. In the meantime, an amendment to the original principles of integrated risk management (COSO 2017 - Enterprise Risk Management - Integrating with Strategy and Performance) has been published, which emphasizes the importance of considering risks in the process of formulating strategy and achieving desired goals.

The integrated risk management model presented in this paper is adaptable to all quality systems and management models for entity management and guidance. Unlike the existing models, it quantifies the magnitudes of inherent risk, its reduction based on the control environment and the internal control system, as well as the residual risk.

Thanks to the evaluation of the entity's materiality, which is based on the existing business balances projected into the future and the analysis of business continuity, managing the entity is future-oriented.

The risk management process is an integral part of planning and managing a business process [4, 5]. This process needs to be carried out during the construction of the development plan and the annual work plan, as well as during the introduction of new business processes. Managing risks related to business processes, i.e. business goals, is carried out indirectly by risk management that is integrated into the planning process or directly for individual business processes.

The risk map is the sum of all individually identified risks, described and evaluated in individual risk questionnaires [6]. The Risk Map is established based on risk analysis from the aspect of external and internal risk factors. The Risk Map is reviewed and updated on annual basis. In case of significant changes in the business organization, as well as in case of significant changes in business processes and necessarily, the Risk Map is updated and re-evaluated in detail every three years. The functioning of the system of internal controls implemented in the entity's acts and legal provisions is assessed based on the defined Risk Map.

2.1 Assessing the Identified Risks

The identified risks in business processes are assessed through an individual risk questionnaire. The individual risk questionnaire contains: Name of the risk; Description of the risk; Causes of the risk; Consequences of the risk; Name of the business process in which the risk has been identified; Name of the risk group; Name of the person, process owner, who is responsible for taking measures to reduce the risk; Probability of occurrence of an adverse event; Financial impact of the adverse event; Total impact of the adverse event; Description of existing control instrument; Evaluated effect of control measures taken; Residual risk; Proposed measures that need to be additionally taken to reduce the risk to an acceptable level.

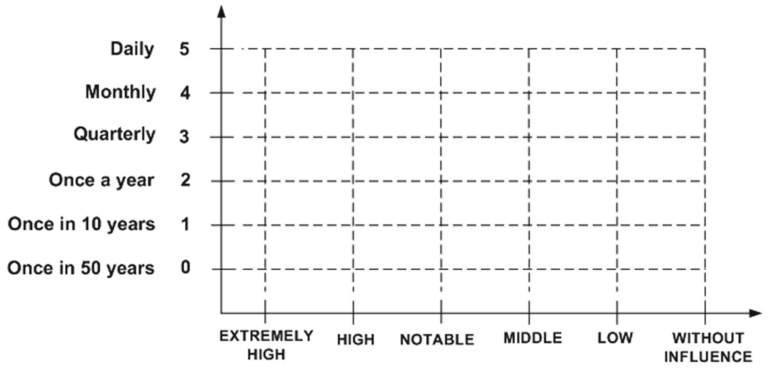

Fig. 1. The probability of occurrence and the financial impact of the adverse event

The model of determining inherent risk is based on the sum of probability of risk occurrence and its financial impact (Fig. 1). The first step in risk management is to determine or assess its frequency, as well as its impact on the company's operations. Risk evaluation is expressed in absolute figures of the sum of individual probabilities of occurrence and financial impact, and the total possible sum of both effects 10 (ten). The individual evaluation is shown below. The probability of occurrence of an adverse event is determined on a scale of 0–5.

The financial impact of the adverse event also determined on a scale of 0–5. In addition to these two assessments, the risk assessment instrument also includes the evaluation of the impact of established control instruments. If the previous risk was represented by the following formula [7]:

$$Z = NR + PR \tag{1}$$

where:
NR - probability of risk occurrence PR - financial impact of the risk.

The financial impact of the adverse event is expressed on a scale of 0–5, depending on the materiality of negative effects, calculated in accordance with the calculation of materiality based on the audit method and financial effects in relation to balance sheet items, along with the ratio analysis of financial data and using Altman's Z-scores for predicting future operation. It is calculated during each re-creation of the Risk Map, reported business results, as well as significant events in the company's operation.

The model could be represented by the following formula:

$$Z = (NR + PR) - KI \tag{2}$$

Here, in addition to the above-mentioned probability of occurrence of an adverse event and its financial impact, we also have KI (impact of the established control instruments). These instruments could also be evaluated on a scale of 0–5, so that, for example, if the probability of risk is high and we express it on a scale with 4, and the impact is also high (4), but we have significant control instruments established and we express them as 5, we would get:

$$Z = (4 + 4) - 5 = 3 \tag{3}$$

Without evaluating the control instruments (the existing system of internal controls), this adverse event would be ranked on the scale as 8, which means that it represents a significant risk that has the possibility of frequent occurrence and a large financial impact on business. However, when we consider internal controls, we see that they reduce the risk to 3, which means that the possibilities of its occurrence, as well as the consequences, will be noticed in time and that it will be managed successfully. The reduction of the measured inherent risk based on the impact of the assessed overall control environment, as the assessment of the Internal Control System applied in the specific business process, is measured on a scale from 0 to 5.

As we already pointed out, the entity's materiality threshold, obtained by the audit method, we adjust to the future by analyzing the existing verified financial statements and Altman's Z-score method of predicting the future operations of business entities.

The advantage of the Z-score model is that it projects individual balance sheet items into the future and "amortizes" any manipulations performed on individual items in the financial statement.

Indicators can be defined as follows: a)Ratio H_1 is the measure of the company's net liquid assets in relation to the total capitalization; the higher the H_1, the higher is the liquidity of the company. b) Companies with high retained earnings in relation to the total assets finance their assets through profit retention. The higher the H_2 ratio, the higher the degree of self-financing of the company. c) Ratio H_3 is a measure of true productivity of the company's assets, independent of any tax or other factor. The higher the H_3, the higher is the company's profitability. d) Measure H_4 indicates the level to which the value of the company's assets can drop (measured by the market value of shares plus debt) before liabilities exceed assets and the company becomes insolvent. The higher the H_4, the higher is the level of debt service. e). The capital turnover ratio is the usual financial ratio that shows how the realization generates the solvency of the company's assets. The higher the H_5, the higher is the turnover ratio of assets.

The Original Method [8]**:**

$$Z = 1,2x_1 + 1,4x_2 + 3,3x_3 + 0,6x_4 + 0,999x_5 \tag{4}$$

Prediction zones: $Z > 2.99$ safe; $1.8 < Z < 2.99$ Gy; $Z < 1.80$ black.

Where: x_1 - working capital/total assets; x_2 - retained earnings/total assets; x_3 - profit before tax/total assets; x_4 - market value of shares/total liabilities; x_5 - realization/total assets.

There are also modified models for private companies and non-manufacturing (service-providing) companies.

2.2 Evaluating the Internal Control System

Evaluating the internal control system is also performed on a scale from 0 to 5, which is presented in Table 1. Evaluated as 0 means that there is no internal control system, 1 indicates that it is not documented, 2 indicates a weak system, 3 means that the system is solid with certain weaknesses, 4 that the system is good, but there is a room for improvement, while 5 indicates that the system is well established in accordance with the strategy. Reliable evaluation of the internal control system requires defining a reliable and valid questionnaire. In our model, the questionnaire is defined and includes 4 sets. Each set consists of a subgroup, and each subgroup includes a number of questions. The questionnaire consists of 4 sets of questions related to: features and integrity of management; organizational and managerial structure; nature of the company's business and that of the business environment; financial result. It can be expanded or shortened, depending on the company where the evaluation of the internal control system is performed. The existing internal control system is evaluated based on the questionnaire and analysis of the company's operation.

In addition to the adequacy of the internal control system, Table 1 presents the level of assurance, as well as the effectiveness of the internal control system.

Table 1. Assessment of the internal control system

Score	Level of assurance	Adequacy of the internal control system	Efficacy of the internal control system
0	No assurance	Does not exists	Does not exists
1	Low level of assurance	Undocumented, personalized, irregular controls	Very weak system, with the possibility of a number intentional and unintentional errors in managerial and operative processes
2	Limited assurance	Weak system, possibility of deviation from goals	Weak, incomplete system, does not allow communication of management and leaves room for errors
3	Adequate assurance	Solid control system with weaknesses that can endanger reaching the goals	Efficient control system, with weaknesses than can lead to failure in achieving the set goals
4	Significant assurance	Solid system with a room for improvement	Efficient control system with a room for improvements
5	Full assurance	Good system in accordance with the strategy and appetite for risk	Efficient, effective, and cost-effective control system, oriented towards achieving the goals

2.3 Risk Management Based on the Proposed Model

The applied model of implementing the risk management process after the established starting point - business objectives in the business process – consists of the following four steps [9]: Event identification; Risk identification and assessment; Acting to reduce risk; Monitoring and reporting.

For *the identified and evaluated risks*, all executives, each from their field, propose measures for their solution in cooperation with the risk coordinator, based on the updated Risk Map. Executives analyze the identified risks and measures to prevent or mitigate them, and in cooperation with the risk coordinator determine priorities in risk management and submit a Risk Reduction Action Plan to the director/chairman of the Executive Board. The risk mitigation action plan defines the risks, the place where the risk occurs, the way of controlling it, and/or other measures that would reduce the risks to an acceptable level. Based on the Risk Reduction Action Plan, the director makes a decision, which defines the risks that need to be addressed as a priority, as well as the ways and time frames for their resolution in the coming period. Through the established management system and the corresponding information system, it is necessary to enable all employees to have clear and precise orders and instructions on their role and responsibilities in relation to the risk management process.

At the end of this presentation, it is necessary to stress that the COSO model is effective only when all five components exist and in function. Therefore, the goal is to improve all those components that lack the satisfactory level of efficiency, while regularly monitoring and continuing good management, updating the data of all components that are well developed and allow the good operation of the control system within each public entity.

3 Conclusion

We are witnessing a growing awareness of importance and role of the risk management function, as evidenced by the growing number of organizations seeking to integrate some of the risk management systems into their organizational culture and management system. Trends in the introduction of risk management have also been encouraged by the necessity of overcoming the consequences of the financial crisis. They are initiated by the introduction of business quality systems, and the current Covid 19 virus pandemic has highlighted the need for organized business risk management. Identification and analysis of risks that may occur and prevent the achievement of goals and business plans cannot be carried out without a defined strategy and goals.

Risk management should be seen as a process that connects business strategy, people, technology, knowledge and information tailored to management decisions. All stakeholders are taken into account: capital owners, creditors, managers, employees, customers and the wider community in which the company operates. Risk management is becoming a strategic tool for business decision makers. Whether it is a for-profit or non-profit organization, the goal of the integrated risk management model is to identify and quantify the risks that may jeopardize the set goals (short-term and long-term).

The risk management model presented in this paper quantifies the inherent risks from the aspect of future operation, quantifies the internal control systems based on in-depth analysis of the control environment of the company and presents the results of various quantification tools through risk questionnaires related to business processes as an integral risk portfolio, which makes a managerial tool for conducting business and taking further action to reduce residual risks. In addition to integration with the company's strategy, it represents the metrics needed to better understand the importance of input risk, highlights the need for a better evaluation of the company's existing internal control system, and thus information on the position of residual risk within the appetite for risk. According to this Model, the position of residual risk within the identified appetite for risks in the operation at the strategic level of the organization is the basis for action planning of measures aimed at reducing risk, or taking the risk in new business ventures, thus representing a planned strategic management instrument.

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Collective Aspects of Capability-Based Innovating Firm

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Abstract. The paper comprises two parts and a conclusion. The first part shows why capability-theory is relevant for the management and some moments selected particularly in relation to this subject. We offer argumentation for five aspects (relevance of management, capabilities and constitutive position of management-subjectivity, management in the context of endogenous and exogeneous heteregeneity of firms, capabilities and resilience, capability theory and knowledge-intensive firms). The second part presents two serious problems that the capability theory faces: a) individual and collective aspects of knowledge in the firm, b) processuality of knowledge-appropriation. Finally, in the conclusion, management is emphasized as the process of trade-offs between different aspects of firm.

Keywords: Innovating firm · Dynamic capabilities · Strategic management

1 The Scope of Capability Theory for Management

The origin of capability theory lies in strategic management. The theory developed there and spread to various aspects relevant for the theory of management. Equally important is its relation with other economic theories, that is, their critical discourse. Namely, the criticism developed by capability theory in relation to the neoclassical theory of the firm is particularly important as it points to the key moments in the life of a firm that can by no means found in neoclassical theory (which typically starts from the well-known "homogenized" production function).

Relevant studies reveal various forms of capabilities such as "organizational capabilities" [1], "operational capabilities" [2], "dynamic capabilities" [3], "ordinary capabilities" [4], "knowledge-based capabilities" [5], "slack-related capabilities"[6] (Edith Penrose [7] strongly emphasized the presence of slack in any time sequence in the company).

This is not the exhausted list; it could be expanded even further. However, regardless of the differences, there is a common thread that highlights the exceptional relevance of capabilities in a dynamic business environment where change, shocks, alternations, "unpredictability" and acceleration have become something usual. The capability theory sheds light on the *dynamic constellation* of the firm as an organizational unit in an environment where "creative destruction" and the corresponding consequences are the

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 318–325, 2022.
http://doi.org/10.1007/978-3-030-97947-8_42

norm. It is not a coincidence that the discussed theory has gained in importance in recent decades when market rationality has intensified both locally and globally.

It would be too much to analyze the "sources" [8] of capabilities in this paper. Yet, we can present a minimum of theory that our opinion is based on and what could be a possible basis for further research. Our work also has other limitations in that it does not consider more complex forms of "knowledge-exchange", transfer-processes in the complex intra-firm relations, or in the network relations [9].

Thus, we are interested in capability theory for the following reasons.

First, it is so elaborated that it can present crucial importance of management for the life of the firm. The development of "dynamic capability" makes the manager become a relevant subject, that is, in contrast to the economic theories that make the role of the manager almost redundant, we have a *constitutive* managerial subjectivity developed here. Capability theory was earlier interpreted as a *managerial-strategic theory of firm* [10]. The capability theory gives us the opportunity to discuss about the entrepreneurial performance of the manager as well as his/her results relating to know-how, assets-commanding activities, or the engagement in development of the processes of learning and establishment of organizational and habitual chains between learning, knowledge and innovation-based practice. Management-subjectivity presupposes the "encompassing" of various activities within a firm that lead to the creation of a firm identity. In addition to "encompassing", the manager is also associated with the activity of "framing" i.e. "sense-making" [11]: in a dynamic environment exposed to constant change, the manager interprets the changes, conceptualizes dynamics that is ambivalent, heterogeneous and exposed to many interpretations. More precisely, management in the indicated constitutive sense conditions the *ways of responsiveness* of the members of the firm. "Meaningful structures" of the company arise as a result of selected activities of managers in relation to market situations and processes.

Second, the dynamic theory of a firm with a constitutive role of manager does not presuppose a simple application of the "incentive and response" scheme. Of course, there are "mechanisms" [12]. that involve "operations, administration and governance of the firm's activities, make a firm capable of producing and selling a defined (and hence static) set of products and services using known technologies, thereby generating at best competitive (and therefore competitively uninteresting) financial returns" [13].

In other words, the mechanisms or "reproductive forms of action" within the company are forms of "ordinary capabilities". However, there is a wide range of phenomena that cannot be encompassed by these forms of capabilities, and "dynamic capabilities", as we see them, converge with such a zone that requires not reproductive but "productive action" that cannot be explained by the mechanisms in the indicated sense (it is not accidental that Keynes' animal spirit is found in some interpretations of dynamic capabilities, which is the absolute opposite of "mechanisms"). "Dynamic capabilities" develop in the context of non-linear changes [14]. If we treat innovation as "productive action" then these forms of capabilities are a prerequisite for innovation. This does not necessarily imply the difference between dynamic and ordinary capabilities. Every productive action is a reformation of the reproductive forms of action in the firm and, consequently, there is always an interaction between dynamic and ordinary capabilities.

Subjectivity of the manager is manifested through mediation between both forms of capabilities in the firm.

Third, the constitutiveness of managerial subjectivity presupposes the emergence of *heterogeneity* of different firms. Instead of homogenization that occurs with the monolithic application of production function á la neoclassical theory, management is here a constitutive element of identity as an idiosyncratic form of the firm. At the same time, this implies that the use of technology and R&D are not developed automatically on the basis of market mechanisms, but that the same processes are the fruit of internal efforts and transformations, i.e. "encompassing" of internal capabilities of firm that allow intensive processing of external incentives. Capability theory offers an explanation of the firm as an *organization* that is embedded in cultural patterns, institutions, certain market and non-market environment, and it represents an organizational "response" to the complex and changing environment.

The indicated heterogeneity can be *endogenous* and *exogenous*. When discussing exogenous heterogeneity, then it is the heterogeneity of different firms competing in the market, and they are exposed to the imperatives of market rationality. If we talk about *endogenous* heterogeneity, then we discuss the possible multidimensionality of the capabilities of the firm (part of which is a multiproduct firm, [15]), i.e. endogenous heterogeneities of business lines. Here, the issue to be explored is which modalities (homogeneous or heterogeneous) ordinary capabilities appear in, that is, what internal heterogeneity of ordinary capabilities exists at the level of the whole company [16].

Fourth, capability theory can be viewed as a response to one of the key problems of management in recent years, namely, *resilience* [17, 18]. Originally, it was a psychological problem, but the term became especially relevant due to the eruption of crisis dynamics and disorders in general, that is, due to the perpetuation of instabilities and unfamiliarity during the crisis in recent years. Resilience refers to the *power of resistance* that develops in relation to the mentioned unfamiliarity.

"Habits as resilience" is also a notion that was not originally from the management; however, it should be noted that habit "as disposition" plays a significant role in firm theories that are based on evolutionary theories, which consider firm's performance in a dynamic environment based on the evolutionary components [19]. It is not a coincidence that capabilities are regarded as in close relation to the notion of habits. A firm as an organization with appropriate management results enables the development of such habits. Accordingly, we think that capabilities should be treated as a "condition for resilience".

Fifth, the capability theory is indispensable from the aspect of knowledge discussion, more precisely in relation to the firm that is knowledge-based. We know that the field of knowledge, acquisition and dissemination of knowledge challenges management. Namely, there are reasons why the application of mechanisms such as market and hierarchy fail in terms of knowledge management [20]. Neither the market nor the hierarchy (or their "combination") can cope with the dynamics of knowledge in modern economics. Capability theory and its emphasis on the constitutive role of management in the absolute market rationality breaks up with the equalization of the firm and the mechanisms of the decentralized market, where there is an intact continuity between

the market and the firm. At the same time, it enables the development of argumentation against the reduction of management in the sense of introduction of hierarchical patterns in the firm. This, as we will see later, puts the manager in a position to implement various mechanisms of "trade-off". In addition, capability theory places the firm in the perspective of "endogenously constituted knowledge" and "procedural interactions between firm members" [10].

2 Two Problems with the Treatment of Knowledge in a Firm and Capability Theory

Knowledge and knowledge acquiring in a firm has been the subject of numerous research during the past decades. The list of relevant articles [21] is impressive. Knowledge-management has been analyzed many times. Undoubtedly, this shows how important knowledge is in a company and modern society and also how important is the problem of knowledge management, that is, knowledge-based resources (anyway, there are various terms in which knowledge appears as a leading indication, for example, knowledge-capitalism, etc.).

In case of a company, emphasizing the importance of knowledge is reflected in a way of presenting the knowledge as an extraordinary factor in the company's positioning on a market. We have already mentioned that there is endogenous knowledge and processual interaction between company members. This leads us to two problems that we would like to point out.

A) According to well-known methodological individualism [12, 22], an individual is "repository/bearer" of knowledge, that is, "immaterial assets". Some theorists express real doubt about abandoning methodological individualism in the theory of a firm. However, if an atomized individual were promoted in a firm, then the firm would represent just a mechanical sum of different individuals who would act as individual bearers of knowledge. This would mean that if a company member leaves a firm (for example, he/she can easily be sacked), then he/she also takes with them the elements of knowledge-asset, that is, knowledge is fixed to individual level.

However, this is contradictory to basic assumptions of capability-theory. It is already indicative that there are different expressions (even based on empirical data) that refer to a company as a bearer/repository of knowledge which connect us with collective dimensions. This way, a research on learning registers a phenomenon of "learning organization". Moreover, the fact that market routes depend on capabilities of firm for learning [23] is emphasized. In other words, a firm is treated as an "epistemic community" (Knorr-Cetina) with "transindividual aspects". Therefore, a firm/organization represents a "learning entity" that is constantly updated. Naturally, there are different learning concepts in a firm, but here we can discuss about "socio-cognitive orientations" [24] that involve "social" dimensions in the firm itself. It is the chain of learning/innovation/knowledge that enables accumulation of knowledge in a firm to provide successful and favorable market positioning.

In addition, some research explicitly indicate to organizational memory, that is, "cognitive memory" that is associated with favorable activities in a firm in which memory is stored [25]. Therefore, there is actually accumulated memory that surpasses individual

mental capacities and is connected with firm/organization as an "organizational capability", which confirms the fact that *trans-individual* aspects play constitutive role in firm development. In other words, these examples show that methodological individualism fails in including social-collective dimensions in firm articulation.

B) Knowledge as intellectual-cognitive and "intangible" resource or "assets" is acquired in a *processual* way [26]. Simplified concepts of learning and knowledge that infer a linear relationship between an assumed goal and realized result should be denied; we should also deny the existence of scheme that projects pre-determined intention which is linearly confirmed through the entire process. This would misrepresent processuality of "endogenous" acquiring of knowledge in a firm and the fact that acquiring knowledge is not a straightforward way towards the assumed goal. In fact, this description of knowledge and learning-based processes would make management unnecessary again because it "encompasses" the processes that involve *non*linear sequences, deviations, irregularities, moving forward and backward. Innovations can occur in "marginal areas" and in multiple forms. Researchers state that innovations arise in such a way that certain problems are, first, perceived as "anomalies" [27], that is, as mere deviations, so that forms of innovations can occur as a response to the same problem. The idea which is first analyzed as "anomaly" further becomes the important source of innovation.

This does not mean that there is no practice in setting goals by managers, but that the same goals arise only in the processes that lead to knowledge. We can, therefore, discuss about processual way of setting goals.

Reductive approach to knowledge, which is always contextual in relation to capabilities of a firm, is not sufficient for clear distinguishing between knowledge and information, or through this approach, knowledge is treated as a mere "application of information" thus causing the complexity of knowledge to be lost. Knowledge in a firm/organization cannot be observed as a property. To be precise, knowledge in a firm cannot be modeled based on exclusive property. The only way of understanding the knowledge that is "embedded" in company's life is by understanding the inclusiveness of knowledge. This means that instead of separate knowledge modality, knowledge in a firm is analyzed as "sharing", "in-between", "heterogeneous fluid element", and company's members are considered to be "knowledge-brokers" [28]. "In-between" means that knowledge is "shared" among members of the firm in constant circulation of knowledge and information. "Inclusiveness" actually converges with the term public good as used in economic theory [29]. Knowledge is "inclusive good" of a firm.

Therefore, capability-theory is important because it provides answers to the questions relating to processuality of knowledge in the firm and relationship between individual and collective horizons of the firm. This theory is viewed as subtle "trade-off" between "individual interactions" in a firm and collective horizon of the firm. Management is also the bearer of this "trade-off" between "individual and collective horizons of the firm".

Capability theory does not converge with unreflective methodological collectivism because it accepts individual results or individual motivations, but it does not accept an individual as ultimate "bearer" of "separate" knowledge. Considering intersubjective processes in a firm, capability theory is open to micro-foundation of capabilities but without subordinating to one-sidedness of methodological individualism. In other words, it accepts macrohorizon of the firm in terms that the firm can be a bearer of knowledge

and memory but does not underestimate microhorizon [30] in terms of openness to individual intentions and aspirations of company members. It can provide information for management theory on the operation of the firm that cannot be reduced to a set of production factors and which assumes complex organization of "intangible assets".

3 Conclusion

Capability theory is important for management theory because it provides better understanding of relevant processes and opens up perspectives on explanations for the following issues:

a) their articulation can enable us to understand business-meditated practice encompassed by management in the perspective of constant fluctuations and acceleration of different market mechanisms at different levels,
b) we understand the way in which management develops its effects in complex endogenous and exogenous environment by having "bounded cognitive capabilities" and knowledge-forms of agents in a firm,
c) we can explain trade-off realized by management connecting "bounded cognitive capabilities" with such evolutionary aspects as routines, habits, and "habits as resilience" as "dispositional features" in the context of "deep uncertainties" of modern business.
d) knowledge can be understood as *autonomous* instance that determines internal and external processes of a company and creates company's identity,
e) we can cast light on certain processes such as chain between learning-knowledge-innovation, that is, we can thematize strategic achievements of management within this chain,
f) we can understand constitutive inter-subjective relationships between company's members and develop mediation between micro and macro elements of a company, thus enabling understanding of the circulation of knowledge among micro and macro elements of a company.

Based on what we have said so far, it can be concluded that development of capabilities of a firm should fall into traditional classification of resources [31]. Knowledge is here understood as an "emergent" in relation to stocks of a firm, or in other words, the firm is a dynamic constellation between tangible and intangible resources and management must be analyzed in this perspective. This paper focuses on affirmation of management of knowledge as non-trivial trade-off between tangible and intangible "assets and resources".

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Data Literacy: An Essential Skill for the Industry

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Abstract. Data literacy is the ability to read, write, critically assess, communicate and extract value of data in different contexts. As such, data literacy is a key competence in the current digital economy, where most transactions require handling high amounts and variety of data. For a data literate workforce in the data-driven industry, there is a critical need for training and educational curricula that address this key competence, both in Higher Education and professional development programs. Through a systematic desk research spanning over 15 European countries, this paper sheds light on how data literacy is addressed in European Higher Education and professional training. Official syllabuses and educational documents have been examined to determine the strengths and challenges of data literacy enhancement, and identify the needs and opportunities for data literacy-specific training programs that promote a data-driven culture within the European industry ecosystem.

Keywords: Data literacy · Information systems · Data knowledge

1 Introduction

Data literacy is becoming critical in the industry and is considered the most important new skill of the 21st century [1]. Data literate employees can enhance the decision-making process and increase competitiveness of a company. Data literacy involves training individuals to access, assess, manipulate, summarize and pre-sent data [2]. Mandinach and Gummer [3] stated that data literacy requires knowledge of other data, such as perception, motivation, process, and behavior. An intricate and rich terminology exists that includes or overlaps with the basic meanings we provided about data literacy (see [2]). "Information literacy", "Digital literacy", "Data education", "Data analytics", "Data science", "Digital literacy", "Media literacy", "Statistical literacy" to mention just few of those terms that may overlap with "data literacy". Therefore, it is still not clear what

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 326–331, 2022.
http://doi.org/10.1007/978-3-030-97947-8_43

is meant by data literacy and skills and knowledge needed to engage in data use and a variety of data. One of the most precise definitions comes from Gartner. According to Gartner [4] "data literacy is the ability to read, write and communicate data in context, with an understanding of the data sources and constructs, analytical methods and techniques applied, and the ability to describe the use case application and resulting business value or outcome."

Schildkamp [5] found that data literacy is the key factor for to improve the quality of teaching and learning when it comes to using data. Industry and academia need to work closely to decrease the gap of understanding what data literacy is. What seems to lack in current academia offers needed for the industry is instead what Grey and colleagues would define as "emphasis on developing critical scrutiny, reflexivity, inventiveness and "infrastructural imagination' document the sources used" [1]. Data infrastructure literacy programs aim not only to equip people with data skills and data science but also to cultivate sensibilities for data sociology, data culture and data politics, what here appears to miss. Occupations that are demanding "data literacy" related terms are shown in Table 1. This information is provided by Skills Online Vacancy Analysis Tool for Europe (OVATE), which is mapped to European Skills/Competences, qualifications and Occupations (ESCO).

Table 1. Occupations that are demanding "data literacy"

Data literacy related skill	Occupation (4 digits ESCO)	% Online advertise-ments for occupations containing the selected skills
Perform data analysis	Financial analysts	50.5
	Life science technicians	43.7
	Database and network professionals	39.9
	Mathematicians, actuaries, and statisticians	35.5
	Systems analysts	31.8
	Industrial and production engineers	31.5
Manage data, information and digital content	Pawnbrokers and money-lenders	82.2
	Credit and loans officers	63.9
	Advertising and marketing professionals	53.7
	Management and organization analysts	50.2

(*continued*)

Table 1. (*continued*)

Data literacy related skill	Occupation (4 digits ESCO)	% Online advertise-ments for occupations containing the selected skills
	Announcers on radio, television and other media	48.8
	Journalists	37.8

The aforementioned data literacy gap is global, and Europe is not an exception. The European Commission (EC) is placing emphasis and allocating resources to address the shortage of a data literate workforce in the region. One of the many initiatives promoted by the EC is the DEDALUS project under the Erasmus + umbrella. The ultimate aim of this project is to bridge the gap between universities and industry by providing a training program for European professionals and Higher Education students near to be incorporated in the job market, which specifically addresses data literacy. DEDALUS project has different stages, the first of which is obtaining an overview of how data literacy is addressed in European Higher Education Institutions and Professional Development programs. The focus of this article is this first stage of the project.

The DEDALUS consortium is formed by universities, research centers, data journalism companies and blended learning cooperatives from different European countries including Italy, the UK, Serbia, Lithuania, Spain, and Austria. The consortium has endeavored to find out the current picture of data literacy provision across Europe, as will be described in the next section.

2 Methodology

To determine the current state of the art of data literacy provision in Europe, the consortium produced the following research questions:

- How is data literacy approached in the Higher Education competency frameworks in different country-region, if existent?
- How do Higher Education curricula across all disciplines cover data literacy related topics?
- Do national HE curricula address specific aspects of data literacy reflected in national/European digital competence frameworks (e.g. Digicomp [6])?

The DEDALUS consortium conducted a desk study with the above questions in mind. Each of the eight components of the consortium was allocated to two European countries. This way, the consortium covered fourteen countries across a wide range of geographical areas. The observed countries were Portugal, France, Austria, Latvia, Netherlands, Croatia, Romania, Ireland, Spain, Italy, Serbia, Germany, the UK and Romania.

Each partner searched according to their own searching habits, to the best of their abilities, although there was a common searching sequence:

1. Searching the partner's own institution, aiming at finding data literacy modules, or modules where data literacy is covered. Search at all levels (undergraduate, masters, doctorate). In order to achieve homogeneity, the search terms were the following: Data literacy, Information literacy, Data literacy in HE, Data skills, Data competence, Data framework, Data awareness, Competences related to data literacy, Data within critical thinking, Data journalism/communication/storytelling, Data interpretation.
2. Searching a second institution in the partner's country, seeking for modules where data literacy could be covered.
3. Extending the search to the whole partner's country and repeat for the second country allocated to the partner.
4. Including competency frameworks and related documents (white papers, roadmaps, strategic documents) at all levels: institutional, regional, national, etc.
5. Place emphasis on the learning aims and competencies developed in the observed module syllabuses and programs.
6. Producing a report with all of the above, to be curated once all partners sent it to the coordinator. The report contains a list of the top five most recurrent competencies found in the observed module syllabuses and programs that are related to data literacy.

3 Results and Discussion

Despite the homogeneity of the methods used, the results of this desk study were highly diverse. Data literacy definitions vary depending on the country, and the linguistic diversity in Europe carries in some cases the absence of a direct translation. That was the case of countries such as Spain, Serbia, and Lithuania. There was also high variation in the maturity of data literacy-specific nationwide public initiatives. For example, in Ireland and the UK there is a nationwide Data Skills Steering group that produces documents advising on how data literacy can be addressed across all disciplines in British universities [7]. Ireland has also documents at national level which address data literacy aspects in the Irish Higher Education system [8], again across different disciplines not necessarily related to mathematics and computer science. In other countries such as Serbia and Lithuania, no such documents with a focus on data literacy at national level were found, using the same search terms. Instead, in these countries data literacy was embedded in digital skills and competencies frameworks, often translated and adapted from wider European Commission's documents. In fact, the DigiComp [6] document was the most recurring search result in all observed countries. Its framework is widely used across Europe to determine digital skills and competencies, and it was found highly influential in shaping the curricula of schools, universities and professional development programs across the observed countries. Area 1 of this document places particular emphasis on data literacy in three main areas:

1. Browsing, searching and filtering data, information and digital content
2. Evaluating data, information and digital content
3. Managing data, information and digital content

With regard to the observed university curricula, there was also a high diversity found in the way data literacy was approached. However, a common trend was observed:

different faculties of different academic disciplines included computer science topics in their modules, addressing data literacy aspects, as can be seen in Fig. 1.

For example, business faculties across most observed universities included modules with topics such as Big Data, data structures, cloud computing, data analytics and visualization, etc. Applied sciences faculties also offered modules with a high variety of computer science related topics.

With regard to learning aims and competencies of the observed programs, these programs aimed at developing a wide range of competencies. After curating all these competencies, the consortium came up with a list of five clusters of competencies:

- Data protection and security: Protecting devices, content, personal data and privacy in digital environments complying with existing laws, ethical standards and best practices.

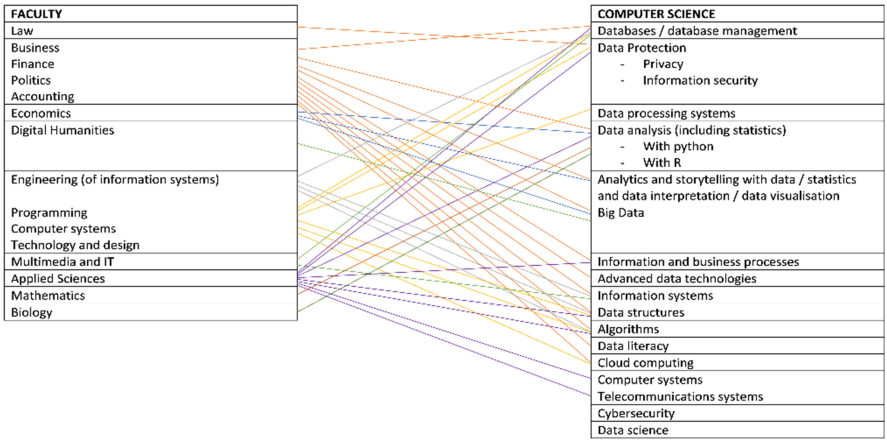

Fig. 1. Links between faculties and computer science topics.

- Data selection and critical assessment: To recognize and select relevant data for identified needs, to extract value from it.
- Data processing: To identify and select the most effective data processing methods using state-of-the-art tools and data formats.
- Data analysis: To use both quantitative and qualitative methods to extract insights from data in different formats from different sources.
- Data visualization: Apply best practices of data visualization in specific contexts (business, science, academia) by using relevant tools and methods.

This study provides few important practical implications for the use of data literacy in the higher education in order to move closer and provide essential skills for the industry.

1. It offers novel insights into which specific faculties to offer computer science topics.

2. Specifically, the outcomes of the desk research process described above can lead to different types of improvement actions (see Fig. 1). For example, it may lead to curriculum changes and include more data literacy specific competencies.
3. There are European solid standards (i.e. ESCO, eCF) which are currently not addressing data literacy and present a valid foundation for this research. However, a unique standard at the EC level is needed for to use of data literacy skills, so that they can monitor, model, scaffold, guide and encourage the use of data [5].

4 Conclusion

In this paper, an overview has been provided of how data literacy is addressed in European Higher Education and professional training. Through a systematic desk research spanning over 15 European countries, official syllabuses and educational documents have been examined to determine the strengths and challenges of data literacy enhancement, and identify the needs and opportunities for data literacy-specific training programs that promote a data-driven culture within the European industry ecosystem.

This study has limitations that should be considered. Our results are based on the desk research conducted in 15 European countries. Future studies should focus on all countries in Europe to provide higher generalization of the results. In addition, scope of the study was only on hard skills. Future studies should incorporate soft skills (see Skills Match framework) as well since they could be a valuable base for data literacy courses at the Higher Educations in Europe.

Funding. This work was supported by the European Commission under the Community programme Erasmus + Key Action 2 Strategic partnership for higher education project "Developing Data Literacy courses for University Students" [grant agreement number 2019–1-IT02-KA203–063359].

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European Startup Ecosystem as a Star of Economic Development

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Abstract. In the recent years, startup ecosystems have been receiving increasing attention from scientists, governments and entrepreneurs in developed as well as in developing countries. Some of the main advantages of startups are their ability to encourage innovation and make a great contribution to the economic development of the countries. Thanks to the growing support and interest in this type of business and high growth potential, entrepreneurship based on innovation, especially in the form of startups, continue being an important issue for years to come. Its importance will especially be emphasized during the process of defining future development strategies at both micro and macro levels. The aim of this research is to present the most developed European startup ecosystems, and their comparative analysis, according to their basic indicators. In this way, the general picture of the European startup ecosystem will be perceived with the necessary consideration of its specifics and growing potential.

Keywords: Startup ecosystems · Entrepreneurship · Innovation · Europe

1 Introduction

This paper presents the results of research and analysis of the environment of European startup ecosystems. The economic and human capital for each of the countries presented below was analyzed, as well as data that concern startups, innovation and entrepreneurship. These data are crucial for gaining a complete picture of the country and finding answers to the questions: whether, in what way and to what extent the state implements innovations, supports entrepreneurship and is a suitable ground for the establishment and growth of startups.

Above all, innovations depend on social and economic factors. They are conditioned by a constant and deliberate search for changes, creativity and taking actions for their development. Based on Schumpeter's view [1] that large firms are a more fertile ground for innovation, therefore it can be concluded that technology and market opportunities encourage innovation. The skill to use and exploit these opportunities in the right way is the core of innovation process. On the market, this becomes a problem for some participants, while for some it is chance – which is the essence of entrepreneurship.

There are many key factors that have an impact on the rate of entrepreneurship – government, capital, financing, legislation, politics, education, cultural factors, technology,

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 332–339, 2022.
http://doi.org/10.1007/978-3-030-97947-8_44

geographical factors, incubators etc. In its most basic sense, the entrepreneurial system can be defined as "an independent set of actors managed to enable entrepreneurial actions" [2].

Innovation and entrepreneurship together have resulted in one, rather new and increasingly present phenomenon: startups. Startups develop own a business model based on some innovative idea, and their primary goal is to grow and conquer the market. They are outlined by uncertainty and risk, which cause very low survival and success rate of startups. However, those startups that manage to survive and succeed on the market can have a big impact on the economy and reach unimaginable proportions of their businesses.

In Europe, the situation in the field of startups varies from country to country, regardless of its size or population. This paper does not only include analysis of developed and large countries such as Germany, France and the United Kingdom, but it also considers developing countries, which, despite a weaker economy, still have a significant role in the ecosystem and contribute to the development of startups in Europe.

2 Literature Review

The idea based on entrepreneurial ecosystems emerged during the 1980s and 1990s as part of a shift in entrepreneurial studies, from individual, personal research to a broader community perspective that includes the role of social, cultural and economic forces in the entrepreneurship process. There is still no intelligible definition of entrepreneurial ecosystems. The first component it contains is "entrepreneurship": a process in which opportunities to create new goods and services are explored, evaluated and exploited. The second component is the term "ecosystem", which is defined as the biological community along with its environment, and any interaction between living and non-living beings. Entrepreneurial ecosystems are often high-growth startups and this type of entrepreneurship is an important source of innovation, productivity growth and employment [2].

At the beginning of the 20th century, economist Schumpeter defined an entrepreneur as "a person who brings new ideas to the market and thus causes economic renewal and progress." A necessary condition is that these innovations must offer more (or the same, but at lower prices) than the previously existing product [1].

Entrepreneurship, recognition and the search for innovation with the aim of creating new values are increasingly recognized as a mechanism for progress in the economy and the community. Productive entrepreneurial activity, including the creation of new organizations, initiative communities, products and markets, is a source of new jobs, technological innovation and financial independence, which can improve living standards and contribute to changes in culture and society [3].

The introduction and diffusion of an innovation are carried out with the aim of creating economic value. An innovation is said to be successful if it provides value, in other words if the benefits after its realization are greater in relation to the funds invested in its development. An adequate combination of a well-formulated innovative strategy, system and business environment is fundamental to the success of any innovation [4].

Startup companies are new companies or entrepreneurial ventures that are in the development and market research phase. Blank defined a startup as: "a temporary organization in search of a scalable, repeatable, profitable business model" [5], whereas Ries stated that a startup is "a human institution designed to create a new product or service under conditions of extreme uncertainty" [6].

They are usually, but not necessarily, associated with high-tech projects. Digitization is a strong mega trend that leads to rapid changes in business conditions in all industries, and poses new challenges for companies of all sizes [7]. One interesting fact, obtained on the basis of research, is that technology-oriented startup companies are usually located in major urban centers. The reason is attributed to the need for a market that exceeds the local level. Also, the number of startup companies in the traditional industry and business sector is increasing. Startup companies go through three phases of development during their life cycle. The first phase is the "problem/solution", which explores whether the market has a problem to solve at all. The second phase is "product/market", which answers the question of whether the realized idea is really what users need. The third phase is the "scale" and it includes the expansion and growth of startup companies, which leads to an increase in the number of employees, increased market share or increased profit [8]. One of the most important challenges facing technology startups is access to capital [9]. Startup companies that record high growth are economic entities that have managed to commercialize new ideas to a large extent, and in a short period of time. These companies are serious candidates for tomorrow's leadership in this industry [10].

The European startup scene has been in the shadow of Silicon Valley for a long time, since it has been the world's number one startup ecosystem for years. The development of the European startup ecosystem has shown that it cannot be a copy of the Silicon Valley startup ecosystem, but that its construction requires development based on the existing strengths of the European economy [11]. First, there was London, Paris, Berlin and Stockholm, but now startups are emerging across Europe, creating a strong interconnected ecosystem [12].

In the past three decades, there have been sudden changes in the terms of ecosystems. The startup ecosystem refers to the phenomenon in which startup companies operate in an environment created to encourage their development and growth. A compatible ecosystem is important for the formation and support of these companies. Startup companies are considered a key player in economic development. The reasons for their significance are their contribution to job creation, which thus increase the employment rate, as well as economic growth at the regional, national and industry levels. The concept of ecosystem is also reflected in entrepreneurship. In the entrepreneurial ecosystem, various interdependent actors or components work to create a new business through startups in a geographic region [13]. Key important elements in a startup ecosystem, which are entrepreneurs, technology, market, support factors, finance, human capital, education, and demography can directly or indirectly affect a startup [11]. All participants in startup ecosystem are aware that establishment of new ventures in form of startups has a direct influence on economic growth of the economy and society of every country [14], and an important role in further strengthening of startup ecosystem.

3 Analysis of European Startup Ecosystems

This analysis was made using official data from the Startup Genome report. With more than one hundred clients on five continents in thirty-eight countries, Startup Genome is a leading research and policy advisory organization for governments committed to accelerating the success of their startup ecosystem. Their mission and influence go back more than a decade of independent research with data on over a million companies from 150 cities [15].

In order to present the results of this comparative analysis in a simple and efficient way, this work presents a pictorial presentation of all important parameters for the functioning of the startup ecosystem.

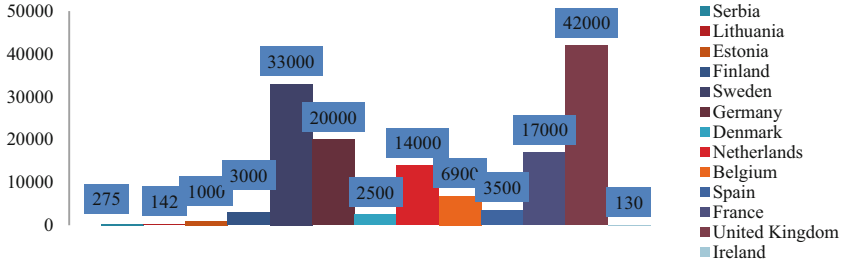

Fig. 1. Total value of the European startup ecosystem by countries (in mil. €)

Figure 1 shows that The United Kingdom has the highest ecosystem value of €42 bn. This is the only country that is in the phase of integration, the last phase of the life cycle of the startup, so such data were expected. Ireland has the lowest value (€130 mil.). The average value of the ecosystem is €11 bn, while the total value of European startup ecosystem is around €149 bn.

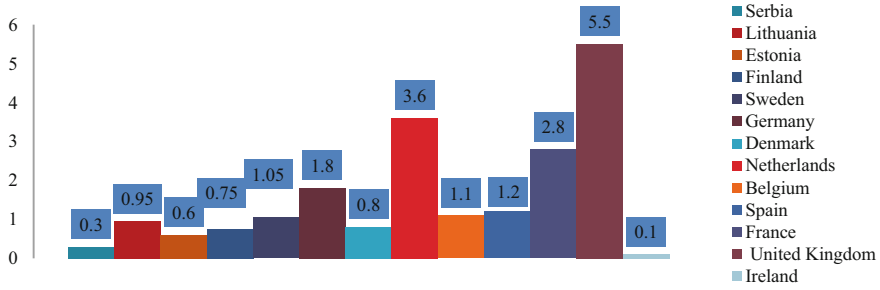

Fig. 2. Value of software output in European startup ecosystems (in thousands €)

Figure 2 shows The United Kingdom has the highest value of software output, while London has 4,7–6,4k. On the other hand, Ireland has the lowest value (<100). The average value of software output in the European startup ecosystem is €1,6k.

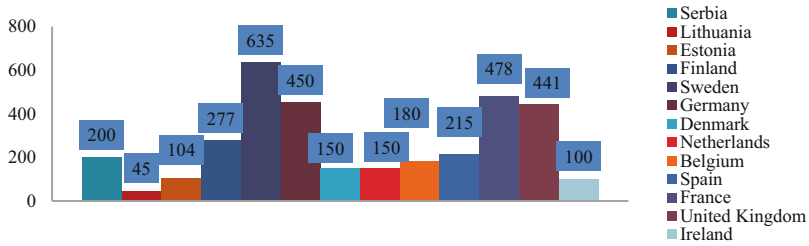

Fig. 3. Average investment in the initial stages of startups in European ecosystems (*in thousands €)*

According to Fig. 3 the country that invests the most in the initial phase of the startup is Sweden (€635 + k), while Lithuania has the least investment in this phase, <€45k. Lithuania is a developing country, and based on previous analyzes from this work, it can be convinced that it has a far smaller population, a problem with the outflow of labor, a drop in GDP, than the other observed countries. The average investment in the initial phase of startup at the level of the European startup ecosystem is €263k (Fig. 4).

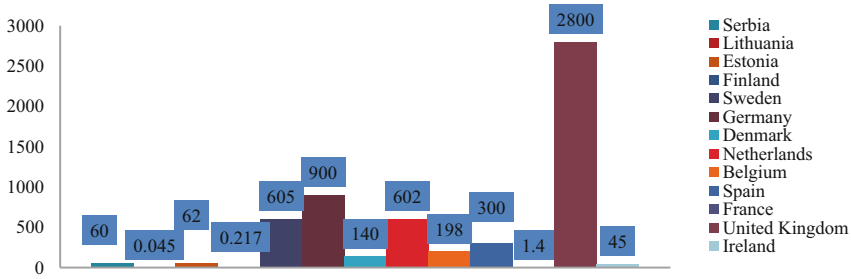

Fig. 4. Total investments in startups in observed ecosystems (*in millions* €)

The picture above shows that the largest total investment in startups is in the United Kingdom (€2.8 bn). Right behind it is Germany with over €1.2 bn. This country has the most cities on the Startup Genome ecosystem map, so this county includes the following cities and their startup ecosystems: Berlin, Frankfurt and Rhineland. Other countries are significantly behind these countries, so this is another indicator that these are two European giants, with the strongest economic and other indicators. The average investment in European startup ecosystem is €440 mil.

In terms of the average annual salary of a software engineer in the ecosystem which is shown on Fig. 5, Denmark leads, with the highest salary of €63.2k. In the previous analysis in this research, Denmark also had the highest average salary. Among the countries with the lowest amount are Serbia (€ 17.6k), Lithuania (€ 24.1k) and Estonia (€ 25.6k), which also had the lowest average wages in the previous analysis and are considered developing countries. The average annual salary of a software engineer at the level of the European startup ecosystem is €42k.

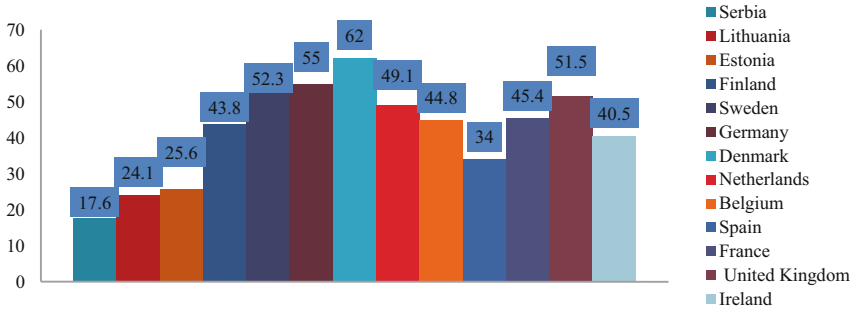

Fig. 5. Average annual salary of engineers in the startup ecosystem of the observed countries (*in thousands €)*

4 Life Cycle of European Startup Ecosystem

Ecosystem life cycle factors measure different dimensions of startup ecosystem. This allows us to determine the exact stage of development in which the ecosystem is – activation, globalization, expansion or integration.

The characteristics of these phases are [15, 16]:

Activation phase – Limited startup experience (founder know-how, experienced investors, advisors and mentors, and community behaviors that support startup success); the biggest challenge is the lack of startup experience and the transfer of resources to ecosystems that are in later stages, which significantly hinders the growth of ecosystems in activation phase.

Globalization phase – Increased experience in this phase of startups has spawned a number of impressive companies, worth $100 million (and more in developed countries); startup output of 800 to 1200 startups (depending on population); a series of these startups attract resources (regional or national) of ecosystems that are in later stages (startups, entrepreneurs, investors), although these resources still mostly go to top ecosystems around the world.

Expansion phase – Output mostly larger than 2000 startups (depending on population); through globally impressive companies – unicorns and exits in the amount of over $ 1 bn (and more in developed countries); attract resources globally.

Integration phase – More than 3000 startup outputs; Global Resource Attraction produce a high and self-sustainable degree of Global Connectedness and flow of knowledge into the ecosystem that sustainably keep its startups integrated in the global fabric of knowledge and ability to produce leading-edge business models and the skills necessary to achieve high Global Market Reach.

Most of the observed countries are in the activation phase, which means that they are in the first phase of development. Also, a large number of countries have entered the second phase of development – globalization. It can be observed that countries with developed economies and strong economies have a more developed startup ecosystem, which implies that the economic strength of a country is an important factor in the development of its startup ecosystem.

The most represented sub-sectors in European startup ecosystem are [15]: Edtech, Fintech and Life sciences.

5 Conclusions

European startups have direct access to the world's largest economy, of 500 million people and a GDP of €25,000 per head. Europe is also a better platform than the U.S. to reach other markets around the world, including rapidly growing emerging markets in Africa and Asia.

World-class companies are created by a combination of brains and technology, and Europe has more than enough of both to compete on a global scale. The continent is home to some of the leading tech and engineering universities in the world, including Oxford, Cambridge and Imperial College in U.K., ETH Zurich, and Delft University of Technology in the Netherlands. Europe also has more developers, numbering 5.7 million, compared to 4.4 million in the U.S.; up 200,000 in the last two years [12].

Entrepreneurship is increasingly recognized as a legitimate career choice, with bright MBAs choosing to start a business rather than climb up the usual corporate ladder. Furthermore, as the ecosystem becomes more established, it is possible to see a growing number of serial entrepreneurs come through, with the experience and funds to build even bigger and better businesses second time round [12].

Based on the research and comparative analyzes conducted in this work, it is concluded that Europe is well on its way to become the leading startup ecosystem in the world. Also, it can be seen that even small, economically less developed countries can be found side by side with large and powerful European countries, and that the development of startup ecosystem can have very favorably affect not only the economic development of such countries, but also the development of education and retention labor force, and above all young people in these countries. In future research, it would be very interesting to compare this data with the situation in emerging markets and the USA as well.

For the further development of the European startup ecosystem, it is necessary to constantly invest and support entrepreneurship, innovation and new technologies, primarily by state institutions. It is important to follow world trends and work to make startups more attractive and accessible to people, to remove the "fear of unknown" and thus encourage creativity and courage to start their own business.

Acknowledgement. The authors acknowledge the financial support of the Ministry of Education and Science of the Republic of Serbia, within the Project No. 47005.

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Digital Transformation Missing Ingredients: Data Literacy

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Abstract. Employees with data literacy skills have become highly valuable in today's economy and labor market. More than ever before, employers demand some degree of data literacy from all employees, regardless of their professional role. New technologies offer many exciting possibilities, but there is no point in having increasingly quantities of data if nobody knows how to explore it efficiently. The aim of this study is to examine data literacy at the Universities and industry as well as the study of existing certification systems for data literacy competences. Our analysis uses results from online survey conducted in 20 countries in Europe and North Africa. The results will support the universities and industry to offer innovative, competence-based, cross-cutting data courses for all the students interested in developing or fine tuning their data competences needed for a successful digital transformation process in the job market.

Keywords: Desk research · Digital competences · European competence frameworks · Open learning systems

1 Introduction

Employees with data literacy skills have become highly valuable in today's economy and labor market [1]. More than ever before, employers demand some degree of data literacy from all employees, regardless of their professional role. New technologies offer many exciting possibilities, but there is no point in having increasingly quantities of data if nobody knows how to explore it efficiently.

Data literacy courses provided by the universities are fragmentary in time and space. The duration of a data science course ranges from one week to a semester or a 1–2-year master's degree. They are organized as face to face lessons, or through web platforms. The syllabuses of these courses are very different. Even though the data literacy profile is often connected to competences in data visualization, statistics, machine learning,

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 340–344, 2022.
http://doi.org/10.1007/978-3-030-97947-8_45

each course gives different weights to these macro topics. As a result, there is not a homogeneous competence profile for data literacy. The needs of the job market have not been adequately analyzed. It's clear that there is still not a mature debate on this topic between academia and businesses. We aim to fill this gap. In response to this, we intend to address the following research question in this study:

- Which competencies are the most important for a "data literate" person from the perspective of businesses?

We used a questionnaire developed by the DATALIT consortium. The DATALIT consortium is composed by 14 experienced partners from 4 Program EU Countries (Italy, Germany, Portugal, Lithuania), 1 Non-EU Program Country (Serbia) and 1 Partner Country from Western Balkans (Albania). In particular we have 5 Universities, 5 SMEs, 1 Educational center, 1 EU network, 1 umbrella organization. The data was collected from 705 professionals from 20 countries. More than 80% of respondents are skilled in data literacy. Data evaluation is found to be the most critical soft skill and creating data classification or rules as a hard skill. The findings of this study can be used to develop new syllabuses underpinned with data literacy related competencies.

The remainder of the paper is organized into four sections. Section 2 presents a state-of-the-art data literacy. Section 3 describes the materials and methods. Section 4 presents the results of survey. This section also includes a discussion. Finally, in Sect. 5, a conclusion and directions for future research are provided.

2 Literature Review

Data literacy is an emerging concept [2] and its definition is an argument of different researchers [3]. Gartner defined "data literacy as the ability to read, write and communicate data in context, with an understanding of the data sources and constructs, analytical methods and techniques applied, and the ability to describe the use case application and resulting business value or outcome" [4]. Other studies stated that data literacy is the ability to access, analyze, use, interpret, manipulate and argue with datasets in response to the ubiquity of data in different fields [2, 5]. All definitions are similar and focus on skills, knowledge and attitudes related to the use of data in order to solve business problems.

When it comes to the industry, it is argued that there is a shortage of data-savvy managers and analysts [2]. Therefore, all stakeholders should pay more attention to data literacy competences and integrate them into current training programs and university curriculum. For instance, Amicis et al. [6] argue that data literacy can enhance the digital transformation of STEM study programs. On the other hand, academia can learn from the trends seen in business where data-driven practices have been embedded for many years [7]. Academia need to work closely with the industry to identify most important competences related to the data literacy.

3 Methodology

Our analysis uses results from an online survey conducted in 20 countries in Europe and North Africa. The focus was on employees who have a good understanding of data literacy. To increase the generalizability of the results, respondents were spread across 27 countries. A total of 705 responses were received. After conducting non-engaged bias analysis, one response was deleted, and the remaining 704 useful responses were available for data analysis. Approximately, 59% of the respondents were male. Age distribution was as follows: under 30 (41.2%), between 31 and 40 (32.9%), between 41 and 50 (15.9%), between 51 and 60 (7.3%), and over 61 (2.7%). About 55.4% of respondents work in private companies, 20.2% work in Higher Education Institutions (HEIs), and the remaining 24.3% work in other fields, like is shown in Fig. 1. 26.7% of respondents said that they have high knowledge on data literacy, 54.2% medium, 12.2% low, while 6.9% admit they have none.

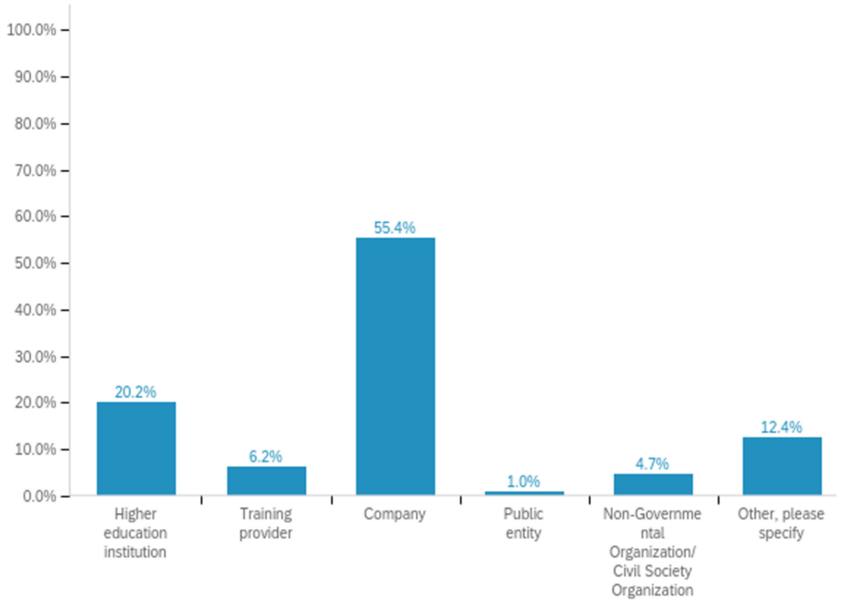

Fig. 1. Type of organization where respondents work in.

4 Results and Discussion

The competences related to soft skills that respondents consider that are most important, for a "data literate" person, are described in order in Fig. 2, according to the respondents ranking. The *data evaluation* was found as the most important soft competence related to the data literacy, followed by the *critical thinking*, *problem solving*, *communication*, and *learning to learn*. In other word, from the perspective of the industry the most valuable

soft skill of an employee is the ability to evaluate or reflect data. For example, a data literate person can assess and use data according to the specific objectives and needs of management.

Also, an essential data literacy competence is critical thinking. Critical thinking allows employees to critically select, assess, and analyze data. Previous studies have also found that a data literate decision maker needs to be able to think critically about data to make informed decisions [3].

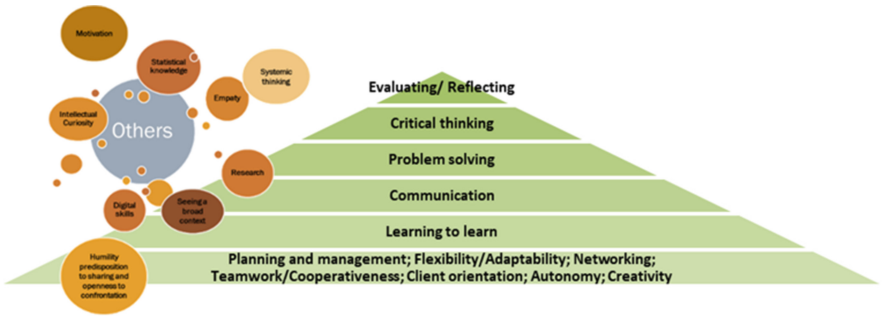

Fig. 2. Most important soft skills for a "data literate" person.

In terms of functional competences, the respondents consider that reading/creating data classification or rules (56.2%) is most important competence, while reading/creating time trends and forecasts (38.9%) is the least important. From the perspective of the business, their employees need to equipped with the skills related to reading or creating data classification. It is of particular importance when it comes to risk management, compliance, and data security. As the second most important hard skill is the ability to search and find data that has already been released. Many sources frequently release data sets for public use. For instance, many governments host open government data platforms for the data they create (see [8]) (Fig. 3).

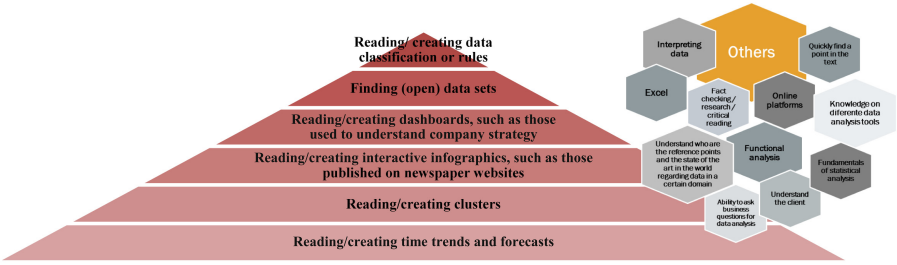

Fig. 3. Ranking of importance of functional competences, related to data literacy.

5 Conclusion

Bridging the gap between academia and industry regarding the key data literacy competences is becoming critical since they are considered the most important issue of the 21st century [2]. The present study showed that the most valuable data literacy competence of an employee is the ability to evaluate or reflect data, and the skills related to reading or creating data classification. The results will support the universities and industry to offer innovative, competence-based, cross-cutting data courses for all the students interested in developing or fine tuning their data competences needed for a successful digital transformation process in the job market.

Finally, this study has its limitations. The notable one is that we used only one research instrument. It is assumed that questionnaire along with desk research can shed the light on all data literacy related competences. Future studies should focus on different methods, such as interviews with experts and focus groups, to confirm or reveal new competences.

Funding. This work was supported by the European Commission under the Community programme Erasmus+ Key Action 2 project "Data literacy at the interface of higher education and business" [grant agreement number 612561-EPP-1–2019-1-IT-EPPKA2-KA].

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Startup Opportunities in South-East Europe Region

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Abstract. The development of the IT industry, new technologies, access to high-speed Internet in almost every part of the world, has led to significant changes and economic growth. The recognition of relevant development opportunities is one of the basic factors of success in modern business. Startup companies represent a vital part of modern economies and they are constantly looking for an adequate business model. It should define the model of their initial financing, the path of their development, use of modern technologies, human and all other resources, and consideration of all environmental factors that affect business of startup companies. This paper will present comparative analysis of the South-East Europe (SEE) region according to the Global Entrepreneurship Index (GEI), which was created by The Global Entrepreneurship and Development Institute, with special reference to the Abilities Sub-Index and its main pillars over a period of 2014–2019. The main goal of this paper is to display the observed parameters, provide and give recommendation as quality basis for further establishment and development of startup companies in selected region.

Keywords: Startup · Development · GEI Index · Abilities · SEE

1 Introduction

One of the main problems of modern businesses that companies nowadays deal with, is that they need to adopt different business model focused on long-term and innovative management instead of relying on traditional business which is mainly directed on short term goals and effects. The globalization brings us to the bigger co-dependency of different participants in the economy, and therefore short-term financial results are not enough for reaching a long-term success.

Companies wanting to survive in the market must apply new ways of doing business which means that they cannot establish only net business profit as their pure goal. Business improvement of a company must be based on management technique which supports creativity, innovation and flexibility of the competitors, also constantly adapting the knowledge of employees- especially of the executive management.

Implementation of the social responsibilities to every function of the business represents a challenge for the companies because it includes different groups and all interested

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 345–354, 2022.
http://doi.org/10.1007/978-3-030-97947-8_46

parties. Modern business market more and more recognizes the importance and significance of socially responsible businesses for achieving sustainable development and positioning the company in the market. The evidence for that are different kinds of global initiatives in the market, which are undertaken exactly for that cause and which are supported by many companies and various interest groups.

The environment is more and more informed and demanding, but a lot of companies are either enduring or not reacting, ie. differently reacting to the demands of the environment. Insufficient information on possibilities and ways of including and resolving social demands leads to the fact that considerable numbers of companies resolve only issues which are prescribed by law. Following the trends and new approaches which bring accelerated expansion of digital communication and modern media are no longer novelty or far future - that became imperative of nowadays reality.

Modern market demands designing the new ways of communication, constant tracking and adjustment of buyers we communicate with. That way, companies cannot just meet the basic legal norm, but also an expected active orientation towards individual, as well as towards overall social community. The new entrepreneurial ventures such as startup companies have very important role in modern business as well. Countries need to enable favorable conditions for these startup companies, a significant factor of strengthening their competitiveness on global and regional level. Startup possibilities that are the subject of research in this report present clear indicator of the relationship between countries and startup companies, as well as their prospects for the further economic development. In this report, countries from SEE, a very important geographical region in Europe, are being analysed. Based on one classification this region consists of the following countries: Albania, Bosnia and Herzegovina, Bulgaria, Greece, Macedonia, Serbia, Croatia, Montenegro, Cyprus, Moldova, Romania, Slovenia, Turkey and Italy [1].

2 Literature Review

Entrepreneurship is set today as one of the most important process regarding the development of certain countries and maintaining the stability of its economy. Whether it is about an external entrepreneurship in small or medium-sized business, corporative, social and entrepreneurship of young women or the rural one, or entrepreneurship of public institutions, each of these types of entrepreneurship implies application of innovation as a tool of change, which bring additional value to entrepreneurs and users of those changes. One of the modern definitions of entrepreneurship says that “entrepreneurship is ability of creation and making visions practically out of nothing” [2].

Joseph Schumpeter is one of the most important theorists in a field of entrepreneurship and innovation, and he classified entrepreneur as a socially specific individual. “This person is characterized as someone who seeks an opportunity, takes advantage of that opportunity and creates a new product, changes the production process, or on the other way creates new market contributions to the economy. Schumpeter calls this activity “innovation” and he claims that innovations are the only domain of the entrepreneur” [3].

Furthermore, the entrepreneurship is a dynamic process which includes organizational creation and innovation which occurs within or outside the existing organization [4].

Entrepreneurship is reflected in ability to change the area of operation as a response to changes of labour value and it represents effort to take a chance, regardless of the resource they currently posses [5]. In terms of the role of the human resources in definition of entrepreneurship, it can be specified that the "entrepreneurship is a process where individuals and teams build value by linking unique inputs in order to take advantage of the chances from surroundings" [6].

Although big companies develop many new ideas, creativity and innovation today are mostly connected to the small companies [7]. Creative thinking became main business technique and entrepreneurs are leading the development and application of those techniques. Actually, the creativity and innovation often lie in the core of small business' capabilities to successfully compete with big companies with developed way of business. This connection of entrepreneurship and innovation is highly discussed in academic literature, especially in last two decades. All innovation must contain novelty to some extent, and that is something which is new for the company, market or for the world. It's also very important to know that innovation it's not something new by itself, but it must also create a sustainable business concept and provide "the successful exploitation of new ideas" [8].

Innovation presents a specific tool of the entrepreneurs, a tool by which they use change as a possibility for completing different production or service activities. It can be presented as a scientific discipline, suitable to be learned and practiced. Entrepreneurs should purposefully explore possible sources of innovation, change and their symptoms, which signify the possibility of achieving a successful innovation [9]. Innovation includes the ability to see connections, to spot opportunities and to take advantage of them. Some of the most important innovation challenges are: identifying or creating opportunities, new way of serving existing markets, improving process and operations, creating new markets, rethinking services, meeting social needs, etc. [10]. Adequate responses to the new challenges can be provided by the newly founded companies such are startups. These companies typically aim to create high-tech and innovative products, and grow by aggressively expanding their business in highly scalable markets [11]. Entrepreneurship theories are more prone to be considered in the early stages of any business or organization. These concepts are integral parts of a startup [12]. Different actors including startups can create startup ecosystem structure [13]. Research that has directly discussed this topic has done so largely by identifying a broad list of elements (such as actors and institutions) in the ecosystem [14–16]. In this kind of structure each player is linked among each other through various connections [17]. As key issue of this concept, the startup opportunites of individual countries are listed. Startup opportunities represent all actual conditions in some area (national or regional), for anyone with great business idea [18], and a desire to turn that idea into a successful business story.

Fig. 1. Structure of GEI Index [Based on 19]

3 Innovativeness Analysis of SEE Countries (GEI Index)

GEI Index was created by The Global Entrepreneurship and Development Institute, and it is a composite indicator of the health of the Entrepreneurship ecosystem in a given country. This index currently takes into account 137 countries.

The GEI measures both the quality of Entrepreneurship and the extent and depth of the supporting entrepreneurial ecosystem [19]. The GEI structure is composed of three building blocks or sub-indices that stand on 14 pillars and it is shown on the Fig. 1. Called the 3As the sub-indices are Entrepreneurial Attitudes with the pillars of Opportunity Perception, Startup Skills, Risk Acceptance, Networking and Cultural Support; Entrepreneurial Abilities with the pillars of Opportunity Startup, Technology Absorption, Human Capital and Competition; and Entrepreneurial Aspirations with the pillars of Product Innovation, Process Innovation, High Growth, Internationalization and Risk Capital. Unlike other indices that incorporate only institutional or individual variables, the pillars of the GEI include both [20].

Table 1. The Global Enterprenuership Index Rank of Southeastern European countries 2014–2019 [19, 21–25]

No	Country	GEI index											
		2014		2015		2016		2017		2018		2019	
		R	S	R	S	R	S	R	S	R	S	R	S
1	Albania	71	32.6	76	30.6	76	30	80	23	83	24	87	22.5
2	Bosnia and Herzegovina	91	27.7	83	28.9	82	28.6	99	19.9	95	21	97	19.5
3	Bulgaria	36	45.4	44	42.7	46	41.6	82	22.7	69	28	61	30.1
4	Montenegro	52	39.5	54	39.1	54	37.5	61	30.2	60	29	57	31.8
5	Greece	58	37,7	47	42	45	42.1	49	34.6	48	37	50	35.4
6	Croatia	49	40.9	51	40.6	51	39.9	59	30.8	54	34	49	36.1
7	Italy	48	40.9	49	41.3	48	41.1	46	37	42	41	36	45.1
8	Cyprus	51	40.2	46	42.5	49	41	43	39	32	48	35	45.6
9	North Macedonia	62	36.1	58	37.1	57	36.6	64	28.7	66	29	85	23.1
10	Moldova	76	31.1	57	37.2	72	31.3	89	21	92	21	94	20.2
11	Romania	40	44.6	42	45.3	42	44.9	45	37.1	46	38	46	38.6
12	Slovenia	22	52.7	29	53.1	31	50.4	26	51	25	54	23	56.5
13	Serbia	68	33.9	78	30.6	74	30.9	79	23.1	74	26	67	28.6
14	Turkey	39	44.7	25	54.6	28	52.7	36	44	37	45	44	39.8

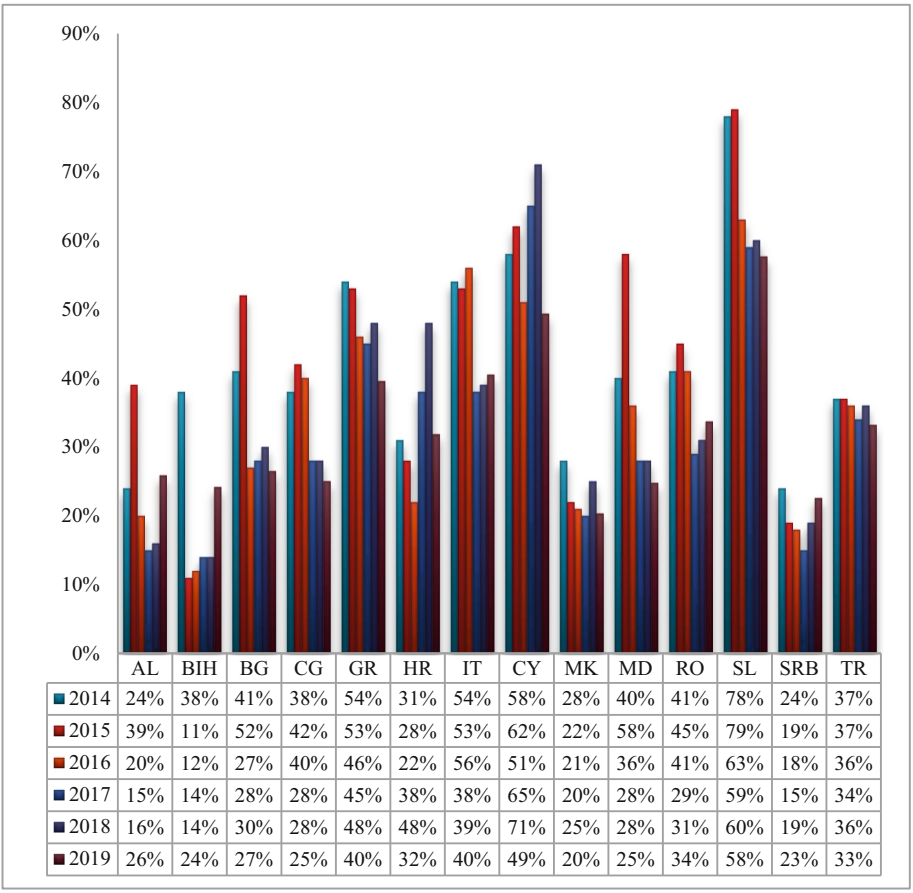
Legend:
R- Rank **S**-Score

The table above shows the positions of Southeastern European countries, according to the GEI index (Global rank and GEI score), in the observed period 2014–2019. An analysis of data for observed period determined that Slovenia was the best positioned country of Southeastern European region, while Bosnia and Herzegovina was the worst positioned. Also, the Slovenia has the highest GEI score.

3.1 Analysis of South-East Europe Region According to Indicator Startup Opportunities

This is the indicator that shows the possibilities in certain countries for starting the startup companies. Legislation also plays an important role, respectively the state policy for encouraging people to enter the entrepreneurial waters. This indicator is very important part of GEI Index and it is an integral part of Sub-Index Entrepreneurial Abilities. *Opportunity startup* looks at the number of startups that would be started by people who are motivated by opportunities, but faced with regulatory obstacles. In the frame of this pillar the institutional variable business freedom is applied [26].

Figure 2 shows the entrepreneurial ability of the countries of SEE, according to the sub-index of startup opportunities, and it can be noticed that 2014 and 2015 are similar years. Slovenia had best results and the worst results had Albania and Serbia in 2014,



	AL	BIH	BG	CG	GR	HR	IT	CY	MK	MD	RO	SL	SRB	TR
2014	24%	38%	41%	38%	54%	31%	54%	58%	28%	40%	41%	78%	24%	37%
2015	39%	11%	52%	42%	53%	28%	53%	62%	22%	58%	45%	79%	19%	37%
2016	20%	12%	27%	40%	46%	22%	56%	51%	21%	36%	41%	63%	18%	36%
2017	15%	14%	28%	28%	45%	38%	38%	65%	20%	28%	29%	59%	15%	34%
2018	16%	14%	30%	28%	48%	48%	39%	71%	25%	28%	31%	60%	19%	36%
2019	26%	24%	27%	25%	40%	32%	40%	49%	20%	25%	34%	58%	23%	33%

Fig. 2. Startup opportunities of Southeastern European countries 2014–2019 [19, 21–25]

while in 2015 the worst results had Serbia and Bosnia Herzegovina. As can be seen a big jump for Moldova, whose results improved in 2015 by 18% compared to the 2014. In 2016 the best position still occupies Slovenia and Italy follows it. Serbia and Bosnia and Herzegovina still have the worst results. It is also noticeable drastic drop in result by Bulgaria by 25%, comparing to the previous year. In the period 2017–2019 the situation changes were the leading place with best result is won by Cyprus. In the same period Serbia, Bosnia and Herzegovina and Albania were still ranked as weakest countries according to startup opportunities sub-index.

Figure 3 shows the average ranking of the region in the observed years. In this review, it can be seen that the result for the whole region was the best in 2015, and after that there is a drastic drop, but starting with 2018, that result is improving. Region experienced a decline in 2017, due to the fact that funds and the government of the countries in previous years have invested in startup companies, and a large number of these companies have failed to survive and to achieve the possibility of being self-sufficient [27]. Observing

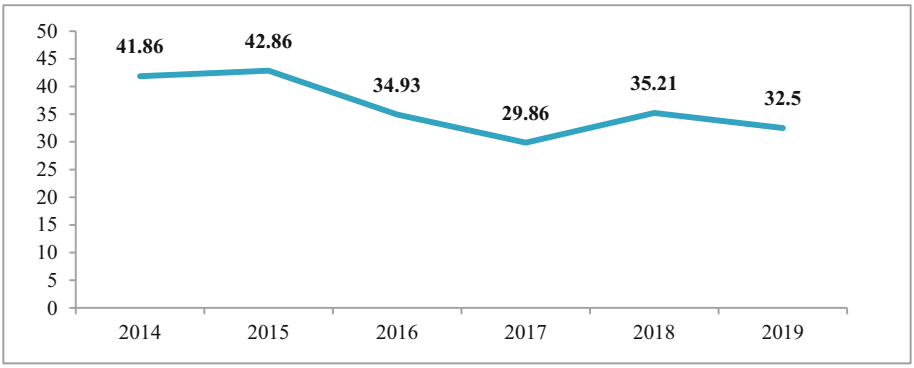


Fig. 3. Startup opportunities average rank of South-East Europe region for 2014–2019

the other indicators within the sub-index of Entrepreneurial Abilities certain conclusions can be drawn, which also significantly affect the movement of startup possibilities of the observed SEE region.

Startups are growing at the centre of a change of paradigm where connections and global networks are key in order to develop new and disruptive technologies [28]. These technologies contribute significantly to the accelerated process of entrepreneurship and innovation development, especially for new ventures and their sustainability [29]. Therefore, one of the reasons for the insufficient opportunities of emergence and development of startups in the region is the unsatisfactory level of acceptance and development of new technologies, which are advancing rapidly in today's world. The acceptance of the new technologies is significantly influenced by various types of financial help, as well as the financial power of the whole region.

The human capital in a region has an impact on the aggregate productivity in the economy, via the externalities associated with it. Also, human capital can result in a major spatial reallocation of important factors [30]. In general, the problem of the SEE region lies in the fact that the outflow of educated labour force, which goes to more developed countries, is increasing. For example, according to the study made by the Croatian central bank, 230.000 people emigrated from Croatia from 2013 to 2016 [31]. This corresponds to and their solution presents greater challenges for the government of these countries in order to preserve their economies, competitive position and national identity. The competitiveness of the region is declining due to the fact that entrepreneurs in this region cannot compete with the entrepreneurs of other European region, and a large number of entrepreneurs have not survived the economic crises that have affected the whole world in recent years, including this still underdeveloped region. The reason for that can be found in the inefficiency of support measures for overcoming these problems, as well as their delays, and the consequences of that are multiple.

Therefore, all future support programs should be in the direction of creating such an environment in which entrepreneurship will be accepted and launching numerous entrepreneurial ventures, with the aim of achieving economic growth, solving the unemployment problem and raising the level of competitiveness [32].

4 Conslusions

By analysing GEI index and sub-index of Entrepreneurial Abilities with accompanying pillars, with special reference to the pillar of startup opportunities, it can be seen that the countries of SEE have not taken leading positions. The reason for that is that countries of this region are still being guided by traditional business models and are a bit repulsive towards accepting new solutions and business models, which are, for example, working well in the region of Western Europe. Untimely acceptance of changes and inadequate attitude towards innovation have led to a decline of living standards for these countries, which has further led to the fact that residents of most parts of SEE are becoming a cheap labour for successful western European companies. Also, this has led to major problems in terms of competitive position of these countries and the creation of a good bases for technological development through the implementation of modern technologies and monitoring of current trends in this area. Based on the results of the analysed reports it can be seen that Slovenia has the best position in the region, while the worst positions are occupied by Serbia, Bosnia and Herzegovina and Montenegro which are not yet member of the EU and there is a room for progress. Countries like Cyprus, Italy and Moldova also have great potential, but they constantly encounter ups and downs and they compete with each other in this uncertain match.

There are two major limitations in this study that could be addressed in future research. First, the study focused on one region, in this case SEE region. Second, for this research secondary data was collected from official GEDI reports whose form and structure are variable by observed years.

Future research may include the comparison of this region with other regions in Europe and the world, as well as an analysis of new significant sub-indices that may indicate the state of startup ecosystems in the region.

Starting a startup company enables faster development of the economy, but from their point of view, there is a conquest and expansion to the new markets. It is necessary to be flexible and ready to accept new innovative solutions and business models in order to successfully achieve this goal and reach satisfactory results. Most countries in the region of SEE do not sufficiently encourage the emergence and development of startups, which should be among priorities in defining policies and strategies for future development. For this purpose, the countries of this region should work on strengthening of the mutual cooperation and exchange good business practice, and work individually on important economic reforms as well. These reforms should be accompanied by good quality legal solutions that would create favorable conditions for sustainable growth and development of entrepreneurs and startup companies.

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Deep Autoencoder Based Leakage Detection in Water Distribution SCADA Systems

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Abstract. Recent advances in industrial automation linked to the development and pervasive implementation of Industrial Internet of Things (IIoT) bring greater networking and communication possibilities, as well as higher volumes of available data about the systems and processes. Modern Supervisory Control and Data Acquisition (SCADA) systems follow these advances by encompassing the convergence between IT (information technology) and OT (operational technology), leading to increased possibilities for data analysis and predictions, providing faster, smarter and more flexible systems with early error detection. Such systems can bring great improvements in water distribution systems, which are becoming increasingly complex following the population growth, and should be reliable and safe since they directly influence public health. In these big and complex systems early error detection is crucial, as it can reduce maintenance costs and detect errors before they reach catastrophic stage. One of the common problems in such systems is water leakage, which usually happens due to pipe bursts and poor infrastructure. With increased system complexity, error detection is getting more complicated and often can be discovered too late. In this paper we propose a model based on a deep autoencoder neural network for leakage detection in water distribution systems. We train and test the model using the LeakDB benchmark algorithm. Such a model can be applied to real world data in a SCADA system to predict and discover water leakage errors, thus lowering the repair costs and improving overall system reliability.

Keywords: IIoT · SCADA · Machine learning · Water distribution system · Leakage

1 Introduction

With the onset of the fourth industrial revolution, or Industry 4.0, modern Supervisory Control and Data Acquisition (SCADA) systems are evolving at full speed. Following the paradigm of Internet of Things (IoT), which brings greater sensory, identification, processing, networking and communication possibilities for diverse objects including computers, mechanical and digital machines, ordinary objects, animals or people in

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 355–361, 2022.
http://doi.org/10.1007/978-3-030-97947-8_47

order to introduce new forms of services, the automated systems are also being increasingly augmented with similar capabilities leading to the Industrial Internet of Things (IIoT). Following these advances, SCADA systems need to adjust in order to encompass the convergence between IT (information technology) and OT (operational technology). Data used for monitoring in these systems is accumulating in increasingly larger amounts. Having more data means that the analysis and decisions process could be more precise, but also more complex and time consuming. In such systems, using only traditional algorithms is often not good enough, so researchers and practitioners turn to more advanced algorithms and models for data analysis and decision support, including machine learning.

Water distribution systems have become so large that human inspection and control is complicated and insufficient. In such big systems, errors could be discovered too late and produce huge damages to the systems. One of the main sources of problems in water distribution systems are leakages in the system due to pipe bursts. It is important to discover these bursts as soon as possible as it could save energy that is needed for water distribution and also lower the maintenance cost. Error detection must be precise enough, with not too many false positive alarms, as sometimes the production must be stopped in order to investigate the error, which leads to additional costs. Operators must have confidence in the monitoring system. They should not be overloaded with alarms as in that case they could miss an important one. It is obvious that huge leakages could create huge damages, but small leakages could as well lead to serious problems as they are usually discovered when it is too late. This is why it is important to have a leakage detection system that can help discover even small leakages.

A water distribution network is a nonlinear dynamic system, so using linear methods or models in order to describe it may not be enough [1]. To detect leakage in these complex systems, different machine learning techniques are applied. Some of the existing papers propose artificial neural networks and support vector machines. Bohorquez et al. tested 1D convolutional network [2] while Abdulla et al. used probabilistic neural networks [3]. Francis et al. used Bayesian Belief Neural networks [4] and Ahmad et al. used the Elman network [5]. For security reasons the water distribution system data are not shared in public domain [6]. To get around this problem, diverse water modeling software is used in order to get data that can be used for training and testing the models. In this paper we use the LeakDB algorithm to generate the dataset [7] for the Hanoi water distribution network (WDN). For leakage detection we propose a machine learning technique based on a deep autoencoder neural network that is created with Long Short Term Memory (LSTM) layers.

2 The Proposed Solution

Our proposed model uses anomaly detection in order to detect leaks. It consists of a deep autoencoder neural network. The autoencoder consists of two phases: the input pattern is encoded to a lower dimensional representation and then decoded again to retrieve the initial input pattern [8]. To present the specific proposed architecture of the autoencoder model we first need to analyze the used dataset.

We generated leakage scenarios using a modified version of the LeakDB algorithm [7], as proposed by Bjerke [9]. Scenarios are created using the widely explored Hanoi WDN, which was first presented in Fujiwara and Khang [10]. The Hanoi WDN consists of 32 nodes connected with 34 links and three loops, without pumping facilities, where sensor measurements are available for each link. One scenario consists of flow and pressure sensor measurements with or without leakage for one month with sensor readings every 15 min. Each scenario can have multiple leakages that are happening on different nodes, with different leak sizes and with different duration periods. We generated 40 such scenarios. We analyzed the generated dataset and decided to use flow sensors data as inputs to our model. Consequently, our model has 34 inputs, since there are 34 flow sensors in the Hanoi WDN. The proposed autoencoder model uses unsupervised learning, so we only have to provide the input data to the model. The model has same input and output size since it is using the autoencoder architecture.

In order to prepare for training the proposed model, we first had to adjust the input data. We separated the input data to leak and non-leak data. The data from scenarios without leaks were used as the training dataset, to represent the normal state of the system, while the data from scenarios with leaks were used as the test dataset. We used 4 leak scenarios for testing. Every leak is defined with its start time and time duration which is different for each tested scenario. All scenarios data are combined together according to the group that they belong to and normalized. The inputs are sorted by dates.

To fit to the input data, the proposed model has 34 inputs, and consequently outputs. To model the data, the proposed autoencoder architecture consists of LSTM layers. We tested several autoencoder configurations with different number of LSTM layers and different number of neurons per layer. The best results that we achieved so far with this configuration was using the autoencoder that consist of 4 LSTM layers with the ReLU activation function. The encoder consists of 2 layers with 10 and 4 neurons per layer respectively and the decoder consists of 2 layers with 4 and 10 neurons per layer respectively. The final model architecture is shown in Fig. 1.

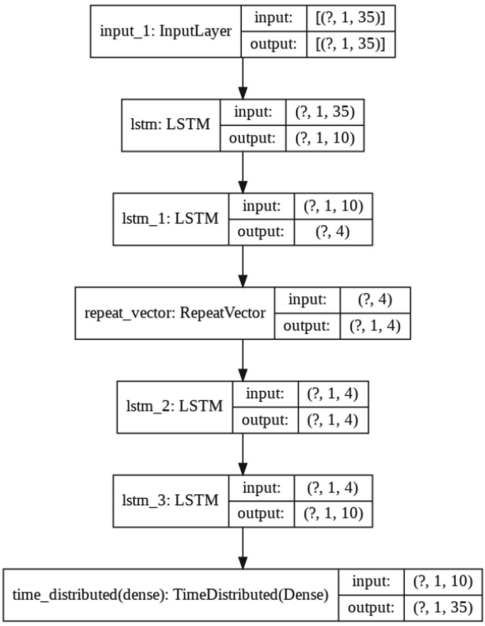

Fig. 1. Model architecture

To train the model, we used the Adam optimizer and the Mean Absolute Error (MAE) loss function. The training was 60 epochs long, while 10% of the training data is used for validation. We also tested the network with higher number of neurons, with and without splitting to batches and with higher number of epochs. There is still some parameter tuning that can be done and is planned for future work.

For training and testing the model we used Google Colaboratory cloud service [11]. It is suited for machine learning and is based on Jupyter open source project [12]. The model is implemented using Python and the Keras library. The data is prepared using data frames from pandas library and sklearn library is used for normalization of the data. For plots representation we used the matplotlib library.

3 Results

Training and testing the model on the Hanoi WDN using the deep autoencoder with flow as input data as described in Sect. 2, showed that the system was able to detect leaks. The error of the training and validation set decreased over time, with higher number of epochs (Fig. 2).

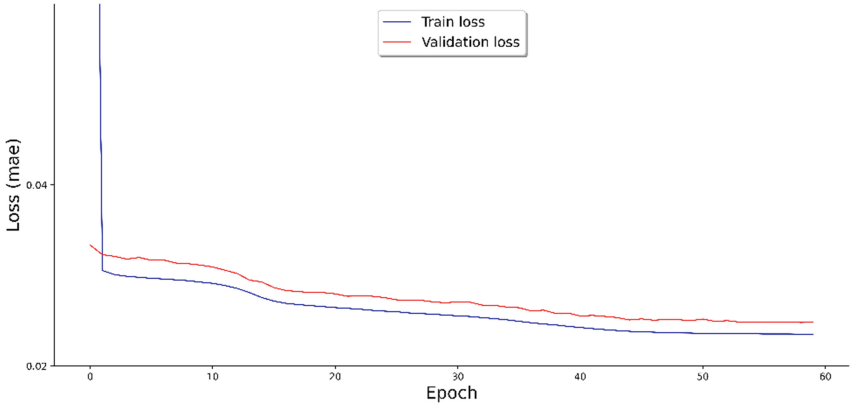

Fig.2. Error of the training and validation set

After the training of the proposed model we plotted the loss distribution for the training set, and selected the acceptable loss threshold according to the data. We then calculated the loss on the test data, and classified the loss according to the previously chosen threshold to leak and non-leak data points. Figure 3 shows the results for the test data, for each of the four scenarios with leaks. For each scenario the first subplot shows the detected leaks, where the red line represents the threshold value, and all data points above the threshold line are the detected leaks, which represent the abnormal data. The second subplot for each scenario shows the true start time and duration of the leak, where the leaks are represented with value 1. As can be seen in Fig. 3, the system could successfully detect leakages according to the loss error for each of the four test scenarios. The leak data for specific scenarios varies, including different leak sizes from low to very large and with duration varying from one day to one month. The results also show that the data with higher loss have bigger leak size which suggests that with some adjustments this approach can also be used for detecting different classes of leak sizes. Since the leaks in the tested scenarios were diverse in size and duration, we did not expect that the system will be able to precisely detect the start and end time of each leak. Even as the model successfully detected each leak, Fig. 3 shows that there is a slight delay in detecting some of the leak data points. These results can potentially be improved by using sequences. In that way the model would be more familiar with previous inputs and could predict leakages in a better way.

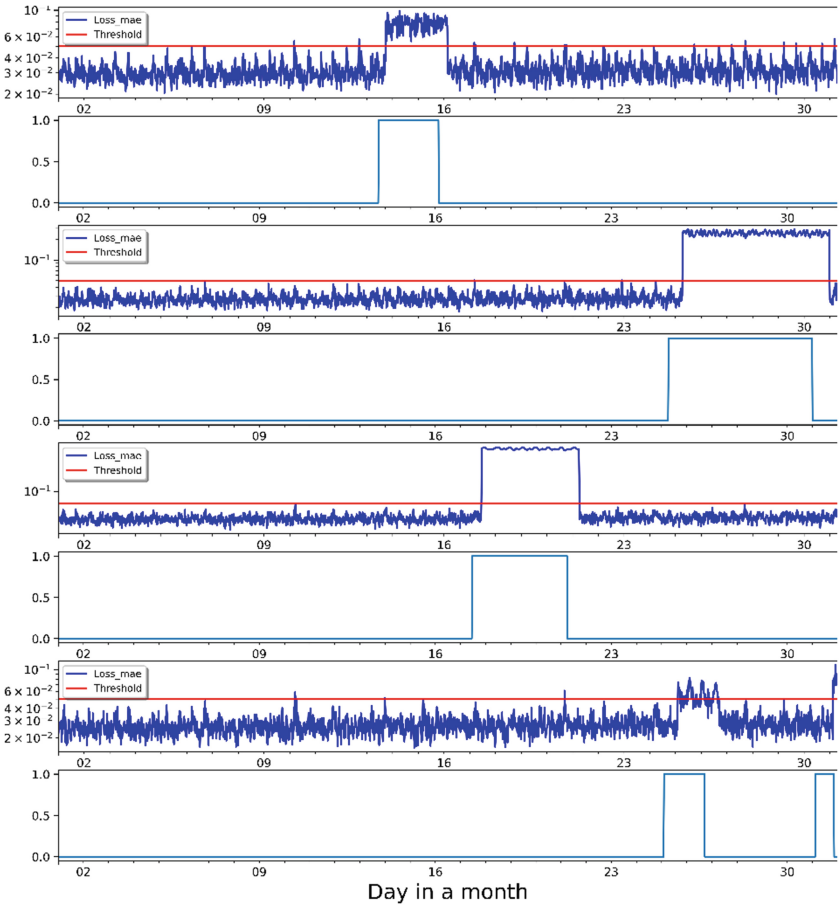

Fig. 3. Loss MAE and threshold for four test scenarios

4 Conclusions

In this paper we proposed a deep autoencoder neural network with LSTM layers for the problem of detecting leaks in a water distribution system. We tested the model on the Hanoi water distribution network using the LeakDB algorithm for generating input data. We tested the proposed architecture with using flow as input data to the model. The results show that diverse leakage abnormalities can be detected using this approach, ranging from small to very large leaks and with different duration.

This paper presents the first results of our research in applying deep autoencoders for leak detection in SCADA systems. Our goal here was to confirm that leakage can be detected using the proposed autoencoder model. We did not go into details of solving false positive alarms or into details of detecting different types of leakage scenarios. In the future we plan to cover classification of leakage scenarios and further adjust the

hyperparameters of the model to decrease error. We further plan to test the proposed model on data from real-world scenarios and implement it as a part of a SCADA system in a water distribution network.

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Distance Learning in Higher Education During the COVID-19 Pandemic

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Abstract. The Covid-19 virus pandemic has changed regular work processes in Higher Education Institutions (HEIs) all around the world. Regular classes have been suspended, and the traditional learning system has been replaced by an online approach. In order to teach continuously, teaching staff from the HEIs has focused mainly on the Learning Management Systems (LMS), software, online collaboration tools, etc. The aim of this research was to explore and highlight the key elements of the used LMS and other collaboration tools that were used as the support for online classes during the spring semester 2020 (ZOOM, Microsoft Teams, Skype, Viber, Go to Meeting, Active Presenter, Discord, Google Meet, Jitsi Meet, etc.), as well as their specific features, and to discover whether the distance learning platforms and tools can facilitate the process of education during the emergency situations. The results of this study highlighted the benefits of different online tools and platforms for distance learning.

Keywords: Distance learning · Online platforms · Higher education institutions · Covid-19

1 Introduction

The Covid-19 virus pandemic caused major changes in the lives of people all around the world. Social distancing was imposed as a consequence of the unfavorable epidemiological situation and it also led to the demand for the development of distance communication. The outbreak of the pandemic has led to significant changes in education and in the regular teaching activities. The pandemic has influenced HEIs and the education system, in the way that regular classrooms have been changed by virtual, applying various online platforms and tools for distance learning.

The teaching staff used more digital tools to enable students to attend classes from different locations. The transition to a distance learning system has caused major changes in education, with the goal to preserve learning outcomes at the same level of quality as in regular teaching processes. The effectiveness of distance learning platforms and tools is reflected in students' satisfaction with the effect of available distance learning possibilities and the educational content provided [1]. HEIs had to reorganize and adapt

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 362–368, 2022.
http://doi.org/10.1007/978-3-030-97947-8_48

to the new situation in a timely matter, improve the online means of communication, and perform regular teaching activities through modern distance learning platforms and tools [2].

2 Distance Learning

Distance learning is a set of tools and processes that involve technology based on digital collaboration in a virtual classroom, by using modern technologies [3]. The development of computer and multimedia technology has vastly influenced the qualitative improvement of distance learning systems. Distance learning implies an innovative learning process through the collection, development, design, and usage of all digital resources [4]. Distance education enables more efficient use of available educational resources, which encourages the establishment and improvement of cooperation and communication between teaching staff and students [5]. Distance learning is a way of communication that contributes to the development of modern education. Many HEIs around the world have used e-learning or blended learning approach, years before the outbreak of the COVID-19. Distance learning at HEIs is considered increasingly global and corporate within higher education [6].

Different types of distance learning technologies enable the learning process to take place continuously. This increased interactivity, overcomed many costs, provided quick and easy feedback, and allowed HEIs to overcome the problem of not being able to provide learning in the classrooms. The transition from the traditional way of learning to the process of learning and teaching "at home" demanded usage of all available digital resources and quick adapting, both for teaching staff and students. To enrich this kind of learning, many teachers supplement their teaching materials with multiple media tools. Classes are complemented by radio shows, audio and video programs, interactive conferences, and more intensive communication with students [7].

COVID-19 and the lockdown caused by it additionally emphasized the importance of key factors that are necessary for the successful conducting of distance learning at HEIs [8]:

1. Digital literacy, skills, and knowledge for managing the digital environment,
2. Integration of formal and non-formal knowledge,
3. Improvement of digital skills through training and learning, to promote digital equality with the competition,
4. Management knowledge, to develop cognitive and affective skills to assess and organize and share knowledge.

Teaching staff from HEIs need adequate instructions for work during the period of mandatory distance learning and professional guidelines for effective teaching. Also, their profession requires opportunities for personal development, to eventually acquire all the necessary knowledge and skills for managing modern technologies [9] and its application within new environment.

In the last decade, the need for a professional and productive way of learning has become more and more present in HEIs [10]. Distance learning to the same extent as

traditional learning in classrooms has both positive and negative elements. Advances in technology have led to the possibility of attending teaching units in "real-time" and to the extend that two-way communication can take place at any time [11].

3 Distance Learning Platforms and Tools

Together with the usage of modern technologies and the internet, distance learning platforms and tools have been developed. Due to the need for social distancing and lockdown caused by the COVID-19 pandemic, distance learning has developed intensively in the world and this form of teaching and learning has experienced a tremendous growth trend as it is proved out to be the only possible solution for overcoming the lack of possibility for applying dominant traditional learning approach.

Distance learning platforms have a very important role in the modern education system. Nowadays, there is an increasing number of students enrolled in online courses at universities around the world. There is a greater need to use such platforms in HEIs because they help to make education more accessible and convenient. Students are imposed with flexible and accessible learning to stimulate their interest in learning [6].

The advantages of distance learning platforms usage are as follows [12]:

1. Ease of access to courses;
2. Lower educational and training costs;
3. Possibility of dividing educational content into modules (weeks);
4. Flexible education;
5. Ability to define criteria for knowledge assessment.

The goal of distance learning by using online platforms is aimed at covering the knowledge of all students to the same extent as traditional learning. Therefore, the way in which HEIs establish systems and resources that should enable stable and effective learning is very important. All parts of such a system should be connected so that the system runs smoothly and so that it does not interrupt the process of learning. Necessary features of distance learning systems include [13]:

1. Creating systems for designing and developing teaching resources that are appropriate for students.
2. Development of operational procedures and administrative mechanisms that are flexible enough for blended and fully online learning.
3. Selection and maintenance of appropriate learning and communication tools that are used for communication between students and teaching staff.
4. Creating a well-organized system to ensure student interaction with learning processes.

4 Methodology

At DIEM the research was conducted on the application and usage of distance learning tools during the epidemic. For purpose of the research, a questionnaire was used, which

was distributed online to students of bachelor and master studies. Target population were students from Engineering Management study program. The questionnaire contained 19 questions, both quantitative and qualitative, and 121 students have responded to the questionnaire. Answering this questionnaire was not mandatory and many online activities and various researches are the main reason why the response rate is not very high. Completing this questionnaire was voluntary.

The questionnaire contained three groups of questions with predefined answers. The first group of questions was related to students' personal info such as age, gender, study level, year of studies, etc. The second group of questions examined students' satisfaction with the availability of distance learning resources. From this group, three questions were related to the usage of distance learning tools: Zoom, Skype, and Cisco WebEx. The tool that was most frequently used was Zoom and 113 respondents had lectures through this tool and just 8 respondents did not use it. Also, 44 respondents had lectures through the Cisco WebEx tool, and 77 respondents have never had lectures through this tool. The third and at the same time the least used tool is Skype, which was used by 37 respondents, and 84 respondents did not use it. The third group of questions aimed to gain insight into students' satisfaction towards the SOVA learning management system (LMS). The University of Novi Sad uses the SOVA (LMS), which has been active since 2018 for blended learning and which is available for all employees and students. The results from the questionnaire show that as many as 116 out of 121 respondents used the SOVA LMS (95.86%).

It is important to emphasize that the questionnaire used for this research was not based on theoretical foundations and it is not a fully reliable way for further scientific research.

5 Results of Research

The highest number of respondents who participated in this research were students of bachelor's academic studies. One-third of the respondents were students of the third year of bachelor academic studies (43), and students from the fourth year of bachelor academic studies (33). The remaining were students from other years.

The questionnaire results gave us the insight into general impression regarding the availability of the necessary resources for distance learning. 93.4% of the respondents stated that they had all resources to follow lectures. 6.6% of the respondents answered that they did not have all resources. The question contained a basic list of needed resources such as a laptop, smartphone, stable internet connection, microphone, and camera. We did not check the details about missing resources for those students who have answered this question negatively. As for the complexity of usage of distance learning platform and tools that were used for lectures 53.7% of respondents noted that they sometimes had problems with following lectures from home. 10.7% considered very complicated and 35.5% had no problems and difficulties. The survey results have shown that the majority of students (67.8%) have spent 1–3 h on the daily basis for distance learning. 21.5% spent less than 1h on average. 10.7% of students have spent more than 3 h daily. According to the respondents, 91% of students had access to all needed learning materials. This question was not furthermore elaborated.

Following graphics can give us insight into the relation of most frequently used tools, their advantages and disadvantages, which can be additionally analysed and used for further improvement of the whole distance learning system.

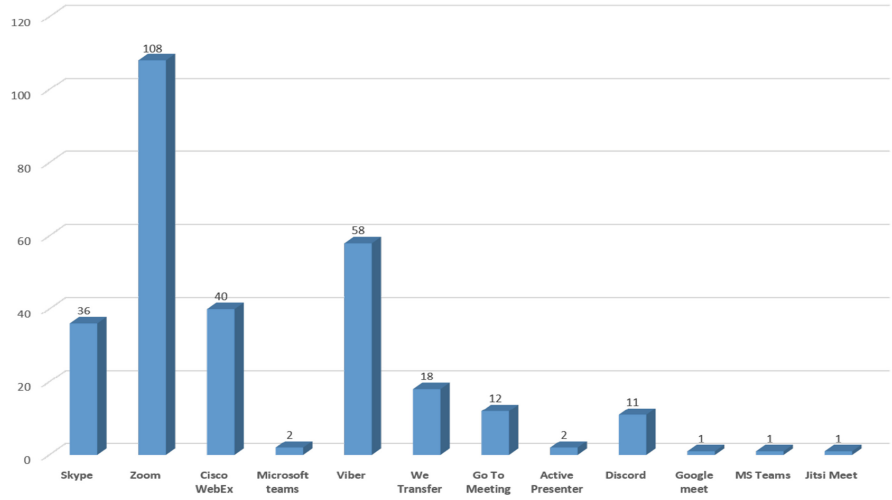

Fig. 1. Most often used distance learning tools

For this question, students had the possibility to state more than one tool was used since teaching staff had the option to choose the one that is most appropriate for their lectures. As it is shown in Fig. 1. Zoom was the most frequently used tool. Also, Skype, Cisco WebEx, and Viber were used significantly often. However, within text questions, students had the possibility to additionally emphasize certain remarks regarding the most frequently used tools, we have noted that as a big lack students found the lectures that were not recorded because they were not able to return to the lecture and listen again.

Analyzing various aspects of distance learning successfulness, we have tried to get insight into different key categories which involve simplicity of usage, availability of learning materials, communication with teaching staff, basic resources availability, etc. As for the category that analyses the usefulness of different learning materials, students have given the answers as it is shown in Fig. 2.

Communication with teaching staff is very important for students, especially in a fully online environment. Beside synchronous communication which was regular through the usage of distance learning tools it is very important to emphasize the students very often used asynchronous communication through forums available within every lecture of each course at SOVA LMS. 91.8% of respondents have stated that they are completely satisfied with communication with teaching staff. From the group of students who were not completely satisfied with communication with teaching staff, most of the comments were focused on the quality of the network and available hardware. When it comes to receiving important information, students are mostly satisfied. Communication through the forum on the SOVA platform also enables receiving information by e-mail, which

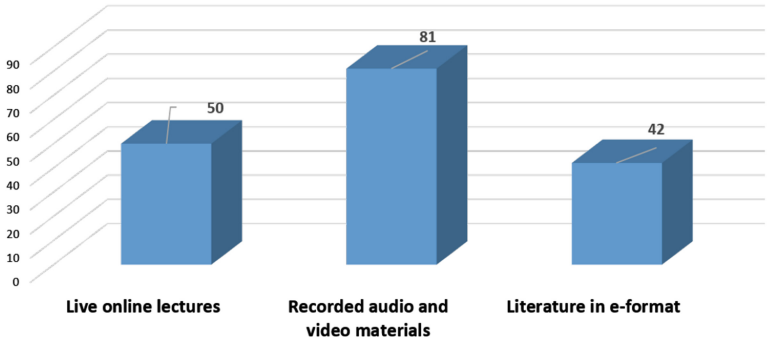

Fig. 2. Attitudes towards different types of learning

greatly facilitates and accelerates two-way communication between students and teaching staff. 97.5% of students have reported that they have received notifications regularly or occasionally when it was needed and expected.

6 Conclusion

DIEM has been using blended learning approach since 2011. The experience gained through that time was very useful and important. However, the current pandemic situation and circumstances required the up-to-dateness of the teaching staff to conduct regular classes in the fastest period with the help of online teaching materials. In addition to knowledge and experience, the teaching staff needed technical and communication skills to efficiently manage modern technology and to quickly adapt to the new circumstances.

Although the majority of students who have completed this questionnaire (58.7%) prefer traditional learning in the classroom, together with a blended learning approach that was already in use, due to the COVID-19 pandemic it was necessary to provide a fully functional distance learning environment. Considering a very short time to adapt to the new circumstances, the results of this questionnaire have shown that the response of the Department of Industrial Engineering and Management was completely appropriate. 95.9% of students are completely satisfied with the organization of distance learning at DIEM.

Distance learning has become very applicable during the COVID-19 virus pandemic. Higher education institutions had to replace real classrooms and traditional learning with distance learning in order to continue regular teaching processes. Such learning encompasses all tools that highlight the benefits of available technologies, to expand and advance knowledge from a remote location. The research covered the most popular distance learning tools used at the Department of Industrial Engineering and Management that were additional help for basis and most important SOVA LMS. Based on the answers of the respondents, it can be concluded that distance learning platform and tools have contributed to the efficiency of learning considering these rapid changes. Although students noticed certain lacks comparing regular classrooms and the virtual ones, the questionnaire concludes that steps that were taken to overcome problems caused by COVID-10 were appropriate, useful and did not require a lot of time to adjust.

All required answers will be further processed and analyzed in order to additionally improve the distance learning system at the Department of Industrial Engineering and Management.

The results from the questionnaire can be used as a help for the improvement of distance learning in the future, for productive distance learning as well as for the effective implementation of learning activities.

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The Impact of the Type of Education on Attitudes Regards Corporate Responsibility Towards Employees

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Abstract. For the use of company's corporate responsibility concept, it is of vital importance to raise employee's awareness about the importance of corporate responsibility to a higher level and to provide the understanding of the importance of its use, as well providing bigger dedication of the employees to the use itself. This study shows the research on the existence of differences in attitudes regarding corporate responsibility towards employees in relation to the type of their education and in what they are reflected. Research was done on a sample of 153 respondents from the public sector of Serbia. By processing the results of the research, it was determined that there are existing differences in attitudes regarding corporate responsibility towards employees in relation to the type of their education and they are determined and analyzed. Defined differences can be the basis for developing different approaches for the employees based on established differences in their attitudes towards corporate responsibility towards employees.

By developing different and specially designed approaches for the employees based on established differences in their attitudes about corporate responsibility towards employees, a significant increase can be achieved in employee awareness regarding corporate responsibility and improving efficiency application of corporate responsibility in the company.

Keywords: Corporate responsibility · Empoyees · Type of education

1 Introduction

People around the world believe that CEOs run companies in the short term because of a unanimous focus on shareholders [7]. Corporate responsibility is a challenge for human resource management and for leaders in organizations. Changed circumstances in the last few decades require an increase in the social responsibility of organizations, which applies to both internal and external stakeholders. This has influenced the change of organizational strategies, as well as strategies of human resource management. The imperative of accepting the concept of corporate responsibility leads, above all, to a change in the role of human resource management and a change in its strategic action. Corporate social responsibility is a strategic issue that transcends the boundaries between departments in the organization and to a large extent, determines the business path of

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 369–376, 2022.
http://doi.org/10.1007/978-3-030-97947-8_49

the organization itself, that is, it is the result of synergistic action of all functions in the organization. Every company has different views on CSR in its business practice [12].

In doing so, human resource management by its nature has a catalytic role in business processes leading to a socially responsible organization which develops its employees as responsible members of both the organization and society.

In modern conditions, corporate social responsibility must be an integral part of its strategy. Although many companies accept a broad vision of CSR, they are hampered by poor coordination and a lack of logic that connects their different programs [8].

At the same time, developing and expanding the role of human resource management in corporate social responsibility would mean providing support for the application of this concept in a workplace in an organization. Such an impact would further contribute to the effectiveness and success of an organization's business, because meeting individual and organizational goals is a prerequisite for a socially responsible organization and a socially responsible individual [2].

For the application of the concept of corporate responsibility in acompany, it is extremely important to raise employee awareness of the importance of corporate responsibility to a higher level [10] and provide understanding of the importance of its implementation, as well as providing greater commitment of employees to the application. responsibilities and development, training and development of employees.

In times of growing competition, organizations need to position themselves as good corporate "citizens" among their employees, customers and public officials, which will award the organization with long-term loyalty [11].

This paper presents research on the existence of differences in attitudes about corporate responsibility towards employees in relation to the type of their education and what they are reflected in. Defining these differences can be the basis for developing different approaches to employees based on established differences in their attitudes about corporate responsibility towards employees. By developing different and specially designed approaches to employees based on the identified differences in their attitudes about corporate responsibility towards employees, a significant increase in employee awareness of corporate responsibility and improving the efficiency of corporate responsibility in the company can be achieved.

2 Corporate Responsibility Towards Employees

Within the organization, corporate responsibility primarily refers to employees and issues such as intellectual capital, lifelong education and training of employees, acceptance and creation of change, rewarding according to commitment and results of work, equality and equal opportunities, which are reflected through responsible employment and promotion policy and health and safety at work.

Knowledge and innovation are becoming a very important factor of competitiveness, organizations have a great interest in the development and training of highly qualified and competent employees and this concept can indirectly affect productivity. The question is not whether, but how the management of human resources will fulfill its mission and play the role that belongs to it in a modern organization operating in the knowledge society [2].

Facing the challenges of modern business, the organization must transform the function of human resource management by moving away from the constraints of the past and to enable human resource management to get a new role, the role of human resources, facilitating and improving processes, ie catalytic, builds relationships and quickly develops specialists [5].

In times of general competitiveness, the biggest challenge for organizations is to attract and retain individuals who are qualified for the job, but above all employees who are willing to learn and apply knowledge. In the conditions of paradigm shifts on which it is based, the organization should find such methods of selection, training and development, evaluation of performance and motivation and rewarding of employees that will enable it to survive in a competitive market environment. Also, it is necessary to apply the principle of greater autonomy and responsibility of employees. In this context, human resource management, as a focus area of global management, motivates all members of the organization to be actively involved in decision-making and operational processes, bearing responsibility for the results achieved. Human resource management fulfills its role through its instruments, communication, equality and equal opportunities, selection, rewarding, performance appraisal, training and development of employees and career development. Although the development and training of employees is gaining in importance and is crucial for success in the knowledge society, it is linked to all other instruments and without their support and interpenetration, it would not be possible to achieve synergistic effects, which can achieve an innovative, learning organization set up on the foundations of holistic management and entrepreneurship, as its inseparable part.

In an effort to bring closer and improve the activities of socially responsible business, organizations design trainings for employees, which aim to explain what is socially responsible business and how employees can contribute and specifically participate in socially responsible business activities in the organization.

The creation of a good image, which represents one of the most important sources of competitiveness for modern companies, is directly related to the manner in which an organization operates and also the degree to which the organization incorporated the principles of CSR into its business philosophy [11].

3 Research Methodology

3.1 Research Hypothesis

The research hypothesis is: There is a difference in the attitudes about corporate responsibility (CSR) of the company towards employees in relation to the type of education of the respondents.

3.2 The Purpose

The objectives of the research are aimed at determining the differences in attitudes about corporate responsibility towards employees in relation to the type of education, based on which it will provide understanding and acceptance of corporate responsibility towards employees and greater commitment to corporate responsibility towards employees.

During the research, the method of examining a representative sample by surveying was used. The research was conducted on a sample of 153 respondents from the public sector of Serbia. The sample consisted of 153 respondents, of which 80 were women and 73 were men. The sample consists of 4 subsamples of respondents: technical-technological professions (67), social-humanistic professions (46), natural-mathematical professions (20) and other professions (20).

4 Research Results

In accordance with the previously established draft research, the thematic set of respondents' attitudes about corporate responsibility (CSR) towards employees in relation to the type of education will be analyzed and if there are conditions for that, the characteristics of each type of education will be defined. The analysis will be conducted on the attitudes about corporate responsibility (CA) towards employees, namely: corporate responsibility (CA) implemented in the mission and strategy, strategic goals are transferred to employees, no discrimination in employment and promotion, equal rights to education and promotion, expertise does not affect advancement, public recognition is given to employees for KO, there are age limits for learning, employees are motivated for personal development, professional development is provided to all employees, employees are encouraged to innovate, projects for employment of socially vulnerable, women are equally represented in management, fair reward for achieved results, reward system is set by managers, expertise and behavior of employees are rewarded, performance evaluation precedes promotion and rewarding, development and training of employees is treated as a cost, responsibility for business is on managers, safety at work adequate to working conditions, measures are injury rates on work and responsibility for business are taken over by all employees.

Each position has 5 modalities: Disagree, Partially disagree, Not sure, Don't know, Partially agree and Agree (Table 1).

Table 1. Significance of the difference between the types of education of the respondents in relation to the attitudes about corporate responsibility (CSR) towards employees.

Analysis	n	F	p
MANOVA	21	7.299	.000
Discriminatory	21	99999.990	.000

The fact that $p = .000$ discriminatory analysis means that there is a clearly defined boundary between the types of education of respondents, that is, it is possible to determine the characteristics of each type of education in relation to attitudes about corporate responsibility (CSR) towards employees.

Table 2 presents the attitudes of respondents with the highest coefficients of discrimination.

Based on the attitudes of the respondents on corporate responsibility (CSR) towards employees, it can be said that:

Table 2. Characteristics and homogeneity for the type of education of respondents in relation to attitudes about corporate responsibility (CSR) towards employees.

	Technical-technological professions	Social-humanistic professions	Natural-mathematical professions	Other professions	dpr%
Employees are encouraged to innovate	I partially agree	I'm not sure, I don't know, I partially agree, I agree	I do not agree	I'm not sure, I don't know, I agree	13.710
Projects for the employment of the socially disadvantaged	I do not agree	I disagree, I agree	I partially disagree, Not sure	I partially agree, I agree	13.353
Public recognition is given to employees for CSR	I disagree, I partially agree	I partially agree, I agree	I do not know	I agree	10.832
Performance appraisal precedes promotion and reward	I disagree, I partially agree	I agree	I disagree, I partially agree	I disagree, I partially agree	9.345
The reward system is set by managers	I partially agree, I disagree	I partially agree	I partially disagree, I'm not sure, I don't know	---	6.554

dpr% - contribution to landmark characteristics.

- employees of technical and technological professions believe that employees are not encouraged to innovate, that there are no projects for employment of socially vulnerable, that public recognition of employees for corporate responsibility is not publicly recognized, that performance appraisal does not precede promotion and reward, but that injury rate is measured at work, and that the remuneration system is set by managers and that women are not equally represented in management, nor that expertise affects promotion and that there is discrimination in employment and promotion, and that not everyone has equal rights to education and promotion, nor all employees take responsibility for business and believe that they are, or do not have an attitude about it, employees are motivated for personal development.
- employees of the social sciences and humanities believe that employees are encouraged to innovate, that employees are publicly recognized for corporate responsibility, employees are summoned for personal development, performance appraisal precedes promotion and rewarding, employees' expertise and behavior are rewarded, all employees take responsibility for business and that there is a fair reward for the achieved results, as well as that strategic goals are transferred to employees, everyone has equal rights to education and promotion, professional development is provided to all employees, occupational safety adequate to working conditions, the rate of injuries is not clear stated that there is no discrimination in employment and promotion, they believe that the development and training of employees is not treated as a cost and that there are no age limits for learning.

– employees of natural sciences and mathematics believe that the development and training of employees is treated as a cost, expertise does not affect advancement, there is discrimination in employment and advancement, professional development is not provided to all employees, employees are not encouraged to innovate, there are no social employment projects vulnerable, public recognition of employees for corporate responsibility is not publicly acknowledged, there is no fair reward for achieved results, strategic goals are not transferred to employees, occupational safety is not adequate to working conditions, corporate responsibility (CSR) is not implemented in mission and strategy and employees are not motivated for personal development.
– employees of other professions believe that employees are publicly recognized for corporate responsibility, there is a fair reward for the results achieved, the expertise and behavior of employees are rewarded, there is no discrimination in employment and promotion, that all employees have equal rights to education and promotion, responsibility for business all employees take over, strategic goals are transferred to employees, employees are motivated for personal development, and corporate responsibility (CSR) is implemented in the mission and strategy, there are projects for employment of socially vulnerable and protection at work is adequate to working conditions, but also to treats staff development and training as a cost and that there are age limits for learning, and that performance appraisal does not precede promotion and reward.

5 Conclusion

Corporate social responsibility is a frequently used concept in modern business practice [3], given that companies are largely responsible for events and activities of wider social significance [9]. CSR has a positive effect on the competitiveness of a company. For certain organizations, their tendency to implement CSR depends on their competitive position [6]. Human resource management, with unlimited support of top management and active cooperation of managers of all functions and levels, who should accept the approach to human resource management with equal enthusiasm, can ensure acceptance of corporate responsibility of the organization and fulfillment of the ultimate requirement for market survival. Human resource management plays a primary role in creating and maintaining a culture that nurtures innovation, creativity (creation) and learning, that nurtures ethics and responsibility and this brings it to a key position in the organization.

Business and survival in today's turbulent environment are based on the knowledge of the organization, in terms of timely and adequate response to challenges. The ability of individuals and organizations to produce and master new knowledge has become a key comparative advantage [2].

The modern approach to employees is applied by organizations that go beyond hierarchical structures and apply holistic management. Starting from the view that the human factor is a key determinant of business success, in modern organizations, their development becomes a focus area of human resource management and business philosophy [4], as well as corporate responsibility to employees. Corporations should carefully develop plans for corporately responsible communication that should provide consistent information and meet the expectations of each of the stakeholders and ultimately build public trust [1].

By processing the results of the research presented in this paper, it was found that differences in attitudes about corporate responsibility towards employees in relation to the type of their education exist and they have been determined and analyzed. Defined differences can be the basis for developing different approaches to communication, training and development of employees based on the identified differences in their attitudes about corporate responsibility towards employees. By developing different and specially designed approaches to employees based on the identified differences in their attitudes about corporate responsibility towards employees, a significant increase in employee awareness of corporate responsibility and improving the efficiency of corporate responsibility in the company can be achieved. From the aspect of training and development of employees in companies, it is necessary to give everyone the opportunity to use their potential, improve performance and incorporate them into the corporate responsibility and success of the organization. There are differences between employees in companies, only one of them is the difference in the attitudes of employees in relation to the type of their education, and it is in these differences that we should look for sources of increasing accountability in applying the concept of corporate responsibility and overall success.

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Energy Flow Model in Industrial Environment

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Abstract. The rational use of energy and energy sources represents a growing challenge, which aims to preserve the environment. Industrial systems, primarily production systems, are one of the largest energy consumers. The aim of this paper is to propose the energy flow model that can be used in industry. The research on material flow, energy flow and the relationship between them would benefit the construction of a resource savings and to form the environmentally friendly enterprise. The material flow is formed when the material runs along its life cycle trace in an enterprise, while the energy flow is formed when the energy runs along the route of conversion, usage, recovery and emission. The energy flow model of a unit will be presented in this paper, for presented case study, based on which energy flow models of a process or an enterprise are developed. The paper proposes a model for energy consumption prediction based on the real data parameters within the observed industrial organization.

Keywords: Energy flow analysis · Energy audit · Industrial organization

1 Introduction

Sustainable business requires from industrial systems to maximize added value with minimal resource utilization. Number of researchers emphasizes the importance of designing models for managing material and energy flows in production organizations [1–8]. The challenge for enterprises in Serbia and in the world is to find ways for rational consumption of energy and energy resources and to plan the proper material and energy flows, their correlations and to form the models that are flexible and applicable to different production and service activities. These models would provide suitable information to design processes with energy and material savings.

Industrial systems, especially production systems, are one of the major energy consumers. Manufacturing industry system is the most analyzed system in the literature [9–13]. By using the standard procedures for monitoring consumption, the impact of material flow on energy consumption is presented in [14] and correlations of energy and material flows are analyzed in [15, 16]. Industrial systems, are usually driven by high production costs and limited material resources. Therefore, these systems have made significant progress in achieving high system performance with innovative approach for energy savings and through new production processes design [17–19].

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 377–384, 2022.
http://doi.org/10.1007/978-3-030-97947-8_50

According to [20], energy consumption in Serbia is 2–3 times higher than in the countries of the European Union. According to the data of the Republic Statistical Office in Serbia for 2014 [21], energy consumption in the industrial sector was 31.17% share of the total final energy consumption in Serbia, while electricity consumption was 26.19%. It can be noticed that energy consumption in the industrial sector has a significant share. Therefore, all resources for possible energy savings and proper energy management should be focused in this sector. The aim of this paper is to present the developed energy management model in the production organization, in order to identify, analyze and optimize energy flows in production processes.

2 Material Flow of Industrial Process

Monitoring and optimizing the energy flow is especially important for manufacturing systems. By having an insight into energy consumption (electricity, heat, water, etc.), represents the priority in the modern business. The production process optimization is particularly important in the automotive sector, where "Just in time" approach to production do not allow losses - material waste and other resources, as well as unforeseen energy costs. According to the authors, the automotive sector represents a model of effective energy management [22–26].

The material flow is analysed of the one production enterprise that is in the automotive sector, located in the south-eastern Serbia [8]. This enterprise was selected as a case study for energy management analysis. The material is delivered to the inbound warehouse. The wires are distributed in the Preparation zone 1 (Sector 2), for further processing. Then, the products from sector 2 as well as additional material for sector 1 are delivered to the Preparation zone 2 (Sector 3) and to the Zone for mode forming (Sector 4). As the production organization produces the final products for two types of vehicles, part of the semi-product is distributed to the Production Line 1 (Sector 5) and within this part is also individual Zone for mode forming for production line 1only (Sector 6), which supplies only that production line.

The second production line – Production Line 2 (Sector 7) consists of two conveyor lines where the previously produced modes are installed. Products are then subjected to the Electric and Visual Control (Sector 8) and packaging and delivery to the Outbound warehouse (Sector 9).

3 Energy Profile of Industrial Process

Identifying the energy profile of industrial process represents the first step for energy consumption planning. Defining an energy profile enables the enterprise to analyze the current state of energy consumption, as well as to plan energy resources and to analyze future activities in order to improve the energy performance. However, the energy profile of an enterprise provides important information on energy consumption parameters and the importance of rational energy use.

In order to identify the energy profile, it is important to define the critical consumers and provide a detailed insight into how much energy is spent on individual parts of the system that do not participate in direct production process, but as a support. Such

systems may be the system of central heating, cooling and ventilation, lightening, hot water sanitary heating, etc. By using the machine design project as well as the consumer identification on site, a list of the main consumers with installed power was made. This data was used to present the consumers and their energy demand: Heating of administrative offices located in the production hall (2% of the total electricity demand), Lighting (1%), HVAC System (3%), Production process (93%) and other consumers (about 1%).

As the production has 5 days a week operational time, in three shifts, i.e. 480 working hours and only the heating system in the administrative offices is turned on 8 h a day, the profile of electricity consumption will not differ significantly from the energy demand. In order to identify the largest consumers, the critical machines and units are identified in the whole production hall. The consumers overview in the production plant and their energy demand is given as: Inbound warehouse (4% electricity demand), Preparation zone 1 (27%), Preparation zone 2 (34%), Zone for mode forming (5%), Production Line 1 (3%), Zone for mode forming for Line 1 (2%), Production Line 2 (9%), Electrical and Visual Control (2%), Training Zone (4%), Compressed Air system (8%).

The largest consumers are almost all process units in production. The provided data regarding recorded energy consumption was used to present the energy performance indicators as part of the energy management system. The energy consumption model was formed in order to estimate the future consumption in this production plant.

The energy performance represents the amount of energy actually consumed (or estimated to be necessary) in order to meet the different needs. In industrial processed it is defined as the realized consumption of energy and energy sources at the organization level in a certain period of time – month or business year. Based on the data on electricity consumption, an overview of the energy performance of the considered processed can be given [27]. For analysis is necessary to define the concept of energy performance indicators. Energy performance indicators are defined as specific energy consumption at the organization level in a certain period of time – month and business year. Energy performance indicators are presented as a ratio:

$$IP(t) = \frac{E(t)}{A(t)} \tag{1}$$

Where are: $IP(t)$- Energy performance indicator; $E(t)$- Amount of energy consumed; $A(t)$- Indicator of monitored activity for which energy is used (quantity of products/services, area of heated space and similar); t- Period of time for which the energy performance indicator is calculated.

It should be noted that due to the complexity of production in the preparation department (preparation zone 1 and 2), about 15,000–18,000 pieces of necessary elements are produced for two main final products, that will be used for analysis. The data refers to the number of final product pieces on a daily basis that is produced in three shifts. As the production organization is in charge of two different projects - Project 1 and Project 2, the number of final product pieces will be expressed as P1 and P2. Electricity consumption data on a weekly basis are not precisely given, but adopted by using monthly consumption and the number of working hours in each week. Energy performance indicators are given for both final product delivered to the customer.

Figure 1 provides an overview of energy performance indicators for products P1 and P2 on a weekly basis during 2018. In this way, the lowest value of indicator can be identified, when electricity is used minimally to reach operational capacity. The critical moments can also be observed when consumption is higher than usual, in order to analyze the causes. This can provide insight into various accident conditions, working failures, break downs in the process and also enable in a preventive way, to avoid such conditions in the future.

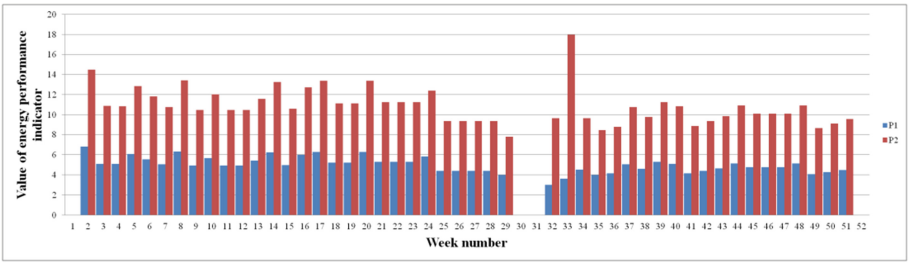

Fig. 1. Energy performance indicators for final product P1 and P2

4 Energy Consumption Model for Analysed Enterprise

The functional dependence between the effects of production process (number of final products) in the industrial process and the electricity consumption is mainly presented as a linear dependence [28–30]. In this way, it is possible to determine the functional dependence of the available data using the least squares method. Figure 2 shows the regression dependence for the final product P1 that is observed. The regression analysis is performed by using the data on monthly production and energy consumption.

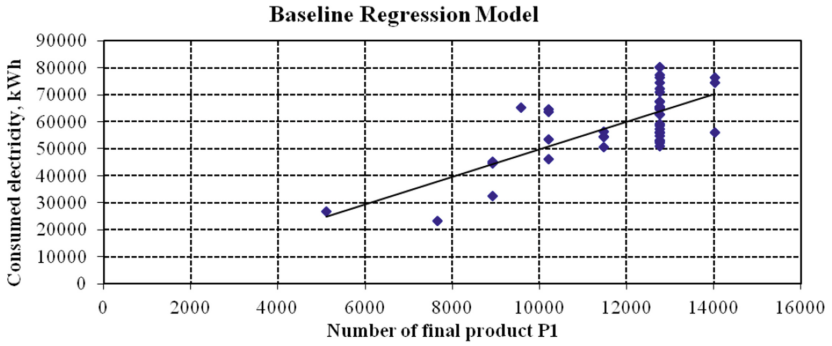

Fig. 2. Regression analysis of electricity consumption dependence and the number of final product P1 for 2018

By using the available data, the functional dependence is determined as:

$$Electricity\ consumption\ [kWh] = 5.011 \times final\ product\ P1 - 189.3205 \quad (2)$$

For further analysis of electricity consumption model, the CUSUM technique or method of cumulative sum of differences is introduced [31–33]. Its advantage is in identifying changes in forecasting, such as critical events and errors that occur. In this case, the sum of the differences refers to the differences between the actual consumption and the consumption expected by the forecast. If the consumption continues to follow the pattern previously defined, the differences between actual consumption and the established pattern become smaller and can reach negative values. Also, in some cases, the difference can be very close to zero. The curve that is formed represents a broken linear dependence, where every change in the slope of the curve indicates a change in the pattern, while all parts that are approximately linear indicate that the pattern is stable. The values obtained by this method are presented in Fig. 3. The critical points of this curve (Fig. 3) indicate changes in the slope, in the analysed case even the direction of the slope of the curve, whose change is observed in the 30^{th} and 31^{st} week when the shutdown occurs and when there is no production and therefore no energy consumption. Based on the curve of the cumulative sum of differences, critical points can be adopted, whose development trend is considered suitable for the analyzed case and that is certainly the reduction of energy consumption and should be part of the curve that is approximately linear or corresponds to a linear dependence. The period between the 39^{th} and 46^{th} week was adopted, as a trend corresponding to the reduction of electricity consumption, which will be further taken into analysis.

Based on the obtained data in the previous steps, it is possible to compare the current consumption and values adopted as predictive, using the method of cumulative sums of differences and the best trend line thus adopted, as well as the average value of consumption during the production of P1 (for 22 months). The described analysis is presented in the common graph in Fig. 4. It can be noted that considered period in 2018 is above the average electricity consumption for the same number of final products P1 for the period of 22 months. The projected consumption realistically reflects the growth trend of electricity consumption in proportion to the number of produced units. The linear dependence of the curve, which is marked as the best prediction, is the result of the chosen trend of the cumulative sum of differences, with the possibility of reducing electricity costs by 8% and indicating the lowest possible consumption that can be achieved for the same number of produced products P1. By further iterative procedure, it is possible to achieve better results of the prediction curve, applying also measures for electricity savings.

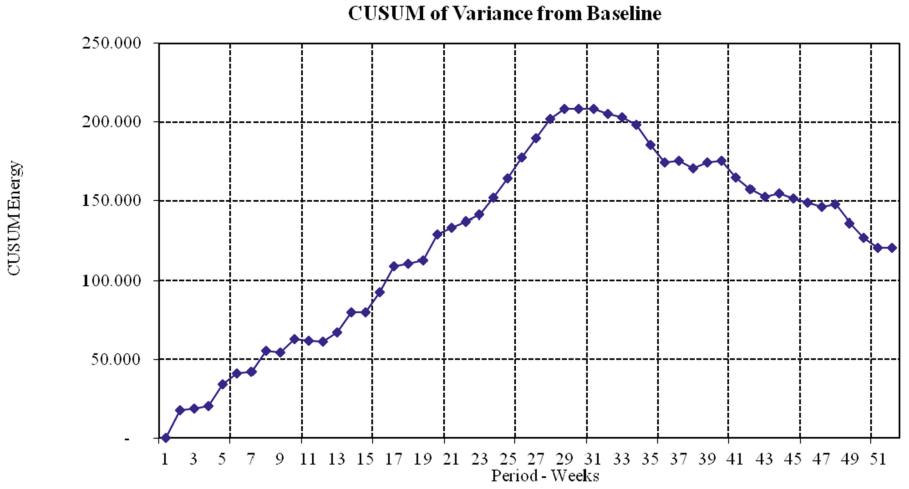

Fig. 3. Results of the method of cumulative sum of differences for electricity consumption forecasting

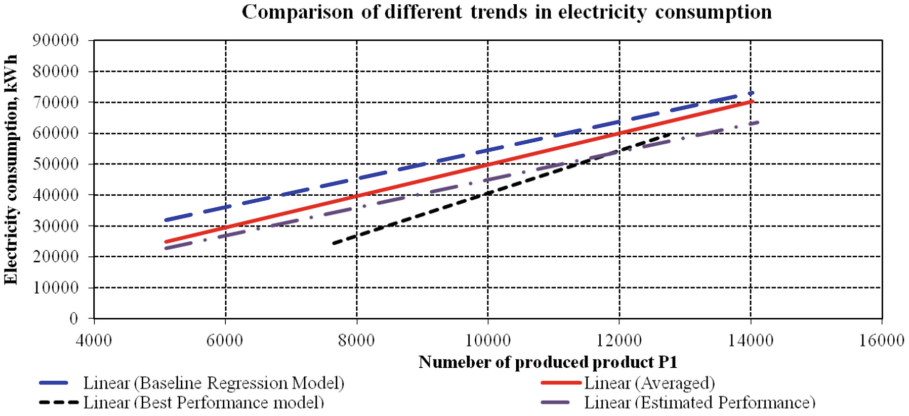

Fig. 4. Comparison of different trends in electricity consumption

5 Conclusion

The case study of energy consumption model in the manufacturing enterprise is presented in this paper. Design of material and energy flows represents the basis for the sustainable production processes in order to have minimal resource wastes and loses, but also to provide positive impact on the environment. The aim was to examine material flows in the manufacturing system, to form energy consumption model in order to foreseen the possible scenarios in the production. Higher energy consumption is related to process itself, but also to the dynamic operations, that should be planned, controlled and monitored.

The complexity of the production processes is analysed so far by using material flow, so the energy flow and consumption are usually negligible. The proposed model include production parameters that are changed on daily basis, especially in dynamic production environment, such as: number of final products produced, number of working hours in each sector presented, number of effective hours as well as downtimes. The model would be developed in the form to follow the patterns that are established in production processes, but to foreseen the consumption peaks and to provide sustain and reliable operation without any unnecessary energy losses.

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Illiquid Markets During the COVID – 19: Blessing or a Curse?

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Abstract. COVID – 19 Pandemic is the game changer. This pandemic changed how we live our lives and conduct our businesses, and there is no industry that was left unaffected by the consequences. Movements on the stock exchanges can be used as indicator for severity of problems to come, and their values should not be disregarded in this time. However, some stock markets react differently to the global events, especially smaller, illiquid markets.

This paper will present the influence that COVID – 19 pandemics had on the Belgrade Stock Exchange and it will compare the performance to benchmark stock exchanges with higher liquidity: Deutche Borse and Warsaw stock exchange. The authors want to show that smaller and Illiquid markets are more resistant to global occurences due to their imperfection. In order to examine the movements authors will use geometric mean and monthly growth rates for main indicies on stock exchanges.

Keywords: Stock market · Illiquid markets · COVID – 19 finances

1 Introduction

Novel COVID – 19 disease outbreak turned the tables on the society as a whole and made all future predictions uncertain. Economy was not spared from the effects of such outbreak, as actions of governments across the globe led to the slowing of the global economy, which can be observed through multiple market stresses that occurred from the beginning of the pandemics. S&P 500, U.S. leading market index, lost more than 35% of the value in the period of little more than a month (from February 19th, when it made historic maximum, until March 23rd). Those results immediately drew comparison to the 2008 Global Financial Crisis and 1929 Great Depression. However, compared to the latter crises, that were driven by the lack of financial resources, COVID crisis is driven by the lack of demand and general consumption. Also, contrary to previous crises, after achieving the drop, S&P 500 index gain almost 45% of the value at the beginning of June, signaling that maybe this crisis is not so serious. Some authors already argue that the downturn was caused more by higher news attention than actual underlying fundamentals and rational expectations [1].

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 385–390, 2022.
http://doi.org/10.1007/978-3-030-97947-8_51

Major European stock exchange indices follow similar pattern when compared to the U.S. main markets. However, smaller markets tend to behave differently when compared to major markets, which can be interpreted as strange due to the strong economic ties between European nations. Emerging European markets tend to be less liquid, even after market liberalization, which is a key component in equity market development [2]. Sterenczak et al. [3] argue that illiquidity is not the most important factor on frontier markets, where possibility of diversification offsets the negative implications of illiquidity. There is also question of effect of pandemic on markets in different stages of development, and it seems that, when compared to 2008, developing countries are less penalized, with most of the attention given to the developed markets due to the death toll [4].

The authors chosen one representative of each class of equity markets from European continent: Frankfurt stock exchange as an established market, Warsaw stock exchange as a proxy for emerging market and Belgrade stock exchange as a frontiers market. We established the representatives according to the market capitalization and average daily turnovers of each market. Market capitalization represents total market value of all stocks traded on certain market, and it represents size of the market, with larger, more established markets having higher market capitalization. Average daily turnover represents trading activity during one market day, and it also represents developments stage of the market, with more developed markets having higher average daily turnovers. Average daily turnover can also be taken as a measure for market momentum and general faith in the market.

Frankfurt Stock Exchange (Deutche Borse) is currently the largest European single market stock exchange, with market capitalization of 1.875 trillion USD (London stock exchange also covers Milan stock exchange, while Euronext market consist of Paris, Amsterdam, Brussels, Dublin, Oslo and Lisbon stock exchanges). Average monthly turnover of 158 billion as of May 2020 [5]. That gives the value of turnover of market capitalization ratio of 8,43%. Its referent index is DAX, with constituents being 30 companies listed on the exchange that had largest turnover in past 12 months. Given its properties, Frankfurt stock exchange is good representative for liquid markets.

Warsaw Stock Exchange (Giełda Papierów Wartościowych w Warszawie) is the biggest single market eastern European stock exchange that operate in European Union member state (Moscow stock exchange has larger market capitalization, while Nasdaq Baltics covers Tallinn, Riga, and Vilnius stock exchanges). With market capitalization of 123 billion USD and a turnover of 5,324 billion USD in May 2020 [5], turnover of market capitalization of 4,33%, and proven track record, Warsaw stock exchange will be used as a representative for emerging markets in this research. Its prime index, WIG 20, which is consisted of 20 biggest Polish companies listed on the exchange, will be used as a proxy for the market.

Belgrade Stock Exchange (Beogradska berza) is the only equity market in Serbia. Its market capitalization is 4,946 billion USD and monthly turnover is 26,814 million USD [6], which gives turnover of market capitalization ratio of 0,54%, signaling that Belgrade Stock Exchange is an frontiers market. Main index on the Belgrade stock Exchange is BELEX 15, which is consisted of 10 companies registered in Serbia and listed on Belgrade Stock Exchange with highest turnover.

2 Methodology

To best encapsulate both volatility and return, the authors decided to present both Standard deviation of index value percent changes (as a proxy for risk) and Geometric mean of index value percent change (as a proxy for return). We also took daily, weekly, and monthly values for all markets, as different timespan can produce different results. In order to better understand market movement during COVID – 19 outbreak, the dataset is divided in two separate sets, one up until 1st of January 2020 and one after that date. The reason for choosing 1st of January 2020 as a separator is because COVID-19 (then unknow virus), was for the first time reported to World Health Organization on December 31st 2019, and International Health Emergency was declared on January 30th, followed by declaration of pandemics on March 11th. Since our goal was to check for any inconsistency between periods prior and during COVID – 19 outbreak, this arrangement gave us the best possible overview of market movements during epidemics.

It is generally considered that four factors influence stock price: expected growth rate, expected dividend payout, market interest rates and degree of risk [7]. As investors are risk averse, they will demand adequate rise in expected growth rate and dividend payout to take on more risky stocks. Standard deviation is measure of dispersion around expected outcomes. When applied to stock valuation, the greater the dispersion in possible outcomes, the riskier the investment [8]. Standard deviation is commonly taken as a proxy for risk in equity valuation, given its ease of use, however it is not the only one, as numerous other measures have been suggested [9].

Geometric mean represents the *n*th root of product of *n* numbers, and it indicates central tendency of set of numbers. It is superior measure of portfolio performance to arithmetic mean due to compounding effect, which arithmetic mean as a measure disregard. Although there are other measures of portfolio performance, such as Sharpe ratio and Alpha, geometric mean proved to be one of the best portfolio performance indicators [10].

3 Results

3.1 Yield

In case of the full year horizon, not a single index gave a positive yield, with DAX 30 performing best with an average daily yield of −0,00178%. BELEX 15 with −0,05263% and WIG 20 with −0.11010% were second and third best. The results for weekly and monthly performances yield the same order, but with somewhat different results (such as weekly yield for DAX 30 being positive), which can be seen in Table 1.

When the dataset is split on 1st of January, order between indices stays the same, with only one instance where BELEX 15 outperformed DAX 30, which can be observed in Table 2.

Table 1. Average yields (one-year observation)

Index	Daily	Weekly	Monthly
DAX30	−0.00178%	0.02576%	−0.03241%
WIG20	−0.1101%	−0.49189%	−2.21292%
BELEX15	−0.05263%	−0.26534%	−1.02838%

Table 2. Average yields (two period observation)

Index	Daily 2019	Daily 2020	Weekly 2019	Weekly 2020	Monthly 2019	Monthly 2020
DAX30	0.04638%	−0.0476%	0.29014%	−0.21842%	0.88059%	−0.6795%
WIG20	−0.07137%	−0.14695%	−0.29578%	−0.67312%	−2.44702%	−2.04536%
BELEX15	0.04803%	−0.14833%	0.18379%	−0.67941%	0.79083%	−2.30768%

3.2 Risk

Standard deviation, as a proxy for risk, has been very conclusive about the least risky market, with BELEX 15 index returning almost 50% smaller values of standard deviation that both DAX 30 and WIG 20, with data provided in Table 3.

Table 3. Standard deviation (one-year observation)

Index	Daily	Weekly	Monthly
DAX30	1.96746%	4.8153%	9.39062%
WIG20	1.92839%	4.75472%	9.0123%
BELEX15	1.00429%	2.46095%	4.03599%

For two period dataset, the results are even more conclusive, with clear distinction between most and least risky markets. Also, it can be noted that risk was heightened across the markets, with most liquid DAX 30 experiencing the biggest rise in risk (Table 4.)

Table 4. Standard deviation (two period observation)

Index	Daily 2019	Daily 2020	Weekly 2019	Weekly 2020	Monthly 2019	Monthly 2020
DAX30	0.88837%	2.60198%	1.81458%	6.37986%	5.5096%	10.7885%
WIG20	1.02286%	2.49613%	2.12672%	6.20466%	5.30928%	10.35399%
BELEX15	0.62277%	1.2544%	0.90346%	3.21963%	1.47194%	4.50453%

4 Conclusion

Three observed markets all reacted to COVID – 19 outbreak in a similar manner. After excellent end of the year 2019, all observed markets reacted strongly to the new circumstances, doubling the risk measure, and experiencing the drop in expected daily yields between 7 and 10 bps. Largest intraday swings occurred on Warsaw stock exchange, when on March 12th 13,28% was wiped out. Frankfurt stock exchange was the only of observed exchanges that had two double digit swings (March 12th loss of 12,24% and March 24th rise of 10,98%). Belgrade stock exchange remained the most stable, with largest intraday swing being 6% drop in value of BELEX 15.

The results are conclusive to some point. It can be noted that BELEX 15 index outperformed WIG 20 in all cases on yearly level, however BELEX 15 gave the worst return during COVID – 19 outbreak. WIG 20 had just marginally better returns when compared to BELEX 15 during COVID – 19 outbreak, but with value of standard deviation of return more than double of that of BELEX 15, WIG 20 also carries significantly higher risk, thus BELEX 15 index, and market that it represents, actually can be declared safer for investing than the market that WIG 20 represents. DAX 30 index gave the best return, both through the whole year, and through the COVID – 19 crisis. The risk at par with the Warsaw stock exchange, which means it is higher than on the Belgrade market, however the difference in yield is enough to offset the risk. The bottom line is that it appears that liquid markets, although riskier, provide better yields in the long run, even when faced with crisis such as COVID – 19 outbreak. Frontier markets proved to perform better during the crisis, much of that owning to its lack of activity. Developing markets gave similar yields, but intraday swings were much higher, which scared – off potential investors.

The authors acknowledge that, with different choice of representative markets, the results could be different. That is why we will broaden our research to include more European markets with varied characteristics. With larger data set the influence of COVID – 19 outbreak on different European markets in different stages of evolution can be properly assessed and stronger conclusions will be drawn.

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The Role of Logistics Controlling in Process Performance Measurement in Industrial Systems

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Abstract. The modern way of doing business and increasing internationalization of the markets require an adequate response from companies, in order to survive and achieve competitiveness. The companies are facing a challenge which implies finding the optimal relationship between achieved goals and spent resources. One of the company functions that participates in creating goals and achieving them is logistics. There is a need and a trend of reducing business costs in modern business environment, which simultaneously set new business conditions for the companies dealing with logistics. The aim of this paper is to show it is necessary to define the quality level of required logistics services and criteria for their realization, such as delivery service levels, end to end costs, employee motivation and others, so performance measurement could yield results. Logistics controlling in the company has a role of defining a model for monitoring the success of logistics processes, using well-balanced criteria and defined methodology. The result of the research that will be presented in the paper is a model that will be applicable both in manufacturing and service companies. It will enable logistic controlling to provide efficient support to logistics management in steering the logistics function. In addition, the model of logistics controlling will have a function of actively managing the performance and business results, and that will ensure business is based on predicting and anticipating future events and market occurrences, and at the same time will lead to resource optimization.

Keywords: Logistics controlling · Service · Performance · Model · Industrial systems

1 Introduction

For long time logistics has been considered a key factor in spatial connection, economic development and market integration of industrial systems. The business of logistics companies must change and adapt to market conditions. Logistic processes are increasingly present in everyday life. There is a need and a trend of reducing operating costs in modern business systems, which at the same time have set new conditions for the operation of logistics companies. In order to achieve sustainable performance of business logistics systems, it is crucial that processes are managed, and process management

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 391–398, 2022.
http://doi.org/10.1007/978-3-030-97947-8_52

requires continuous measurement of their performance. Measurement should be linked to a higher-level organizational goal to ensure that processes are geared toward that goal, and to assess their contribution to that goal. In addition, the measurement of the process should also relate to the performance evaluation of the people involved in their realization (Jeston and Nelis 2008).

By measuring a company's performance, we learn how efficient and effective we have been in doing business. In order to measure the performance of logistics processes, it is necessary to define business goals. A defined measurement strategy is a prerequisite for successful planning, implementation and control of various activities which together form the function of logistics. It is especially important to coordinate planning and implementation processes, to provide decision makers with the right information.

In order for performance measurement to give results, it is necessary to define the level of quality of logistics service. Previous research in the field of measuring the performance of logistics processes show a large number of interesting results, but also some shortcomings, especially when it comes to methods applicable to measuring the overall logistics performance. The shortcomings observed in previous research most often arise from the "differences" of the economic approach, which focuses on measuring financial aspect, and the engineering approach, which focuses on measuring physical quantities. In this paper, we will try to combine these two approaches with a model proposal that would be acceptable in all industrial systems.

2 Logistics Controlling

Logistics is a very complex concept, which is not easy to define. And that is also relevant for logistics controlling. The first concepts of logistic controlling appeared in the eighties and nineties of the last century, and different authors interpret the goals, significance and functions of controlling differently. In the initial stages, there was an interpretation that logistics controlling is the same as control of logistics processes. As logistics controlling concept was developing, many authors pointed out that controlling is much more than standard control and represents integrated support to logistics management.

It can be said that the basic functions of logistic controlling are: planning, management, control and information. Analyzing the research in the literature, it can be concluded that the issue of logistics controlling attracts a lot of attention and that, although significant progress has been made in the last decade in the model of logistics controlling that would be applicable in certain companies, there are some issues that are not completely solved.

A logistics controlling model that would be based on measuring the performance of logistics processes would largely solve these issues and make the process more efficient and economical.

The model would be based on several hypotheses:

- to ensure efficient management of the logistics function in industrial systems.
- to have the function of actively managing performance and business results of industrial systems.
- to ensure that the operations of the logistics system are based on predicting and anticipating future market events and phenomena.

- implementation of the logistics controlling model with its instruments affects the improvement of monitoring and cost optimization.

In today's business environment, companies must achieve high logistics performance combined with as low costs as possible and high-quality logistics services. Companies are increasingly forced to adapt all products to market demand, which requires technological development and innovation, meeting high requirements related to delivery and reliability, all with a satisfactory level of quality and lower costs. Conventional, resource-oriented planning and production management are unable to meet these requirements. A well-organized logistics system can ensure the company to maintain a competitive advantage in the market because it efficiently manages logistics processes and thus increases customer satisfaction while maintaining delivery quality and reducing costs. Only planning aimed at the company's goals can assure excellence in management of logistics processes.

The logistics controlling model is based on successful planning of logistics processes, active management of performance and business results of logistics processes, as well as measuring and monitoring the quality of logistics services. Based on the research, it was concluded that the planning process in the company would include:

- Logistics process planning is based on information from the market
- Planning would be based on logistics processes monitoring
- Based on planning, resource costs would be reduced (cost reduction)
- Logistics process planning would be integrated into the overall company planning process
- Logistics controlling participates in the company planning process.

Logistics process management combines the art of distributing products or materials from source to end user, with all related activities. The goal of logistics is to ensure that materials and products are available in the right place at the right time with the right quantities and quality to meet demand. The availability of products and materials can be observed through the logistics system. On the input side, logistics process management comes down to minimizing the costs incurred in the process of inventory management, warehousing, transportation and other costs of logistics activities.

In essence, logistics management is the task of balancing between minimizing costs and ensuring that the set goals are achieved. In all of this, trade-offs must be made between key elements such as the level of services, inventory costs, inventory acquisition costs, transport costs, storage costs and administrative costs. This is not an easy task because there is a complex interaction between the different components of the logistics system. Cost reduction in one logistics process is reflected differently in the cost of another logistics process. And we have to be aware of this impact, in order to make proper decisions.

3 Monitoring the Performance of Logistics Processes

The concept of measuring logistics performance includes a wide range of planning and control measurements related to logistics controlling. Such performance measurement

includes various productivity measures, customers, service level, logistics service execution time, turnover rates, inventory control, etc., as well as financial measures: accounting costs, cost determination, budgeting, standard prices and so on.

Why do we need to measure logistics performance? There are several answers:

- consideration of different aspects of logistics processes
- direct management of raw materials and products (materials)
- setting logistics goals
- control of logistics goals fulfillment
- defining the quality level of logistics services and processes.

Logistics performance measurement needs to be expressed quantitatively and this is one of the measurement issues. In addition, there are problems such as: what are the measures that best reflect a particular logistics process, whether it is possible to convert all information into quantitative measures and how much are the costs incurred by measuring logistics performance [2]. One of the main problems is which factors we can express directly with a certain quantitative measure and how we can interpret the obtained results so that we can make corrective measures based on them. The best example of this is the productivity of logistics processes. It is known that some companies need less resources to achieve better results, as a result of continuous improvement process they developed over the years, whereas some companies still lagging significantly [1].

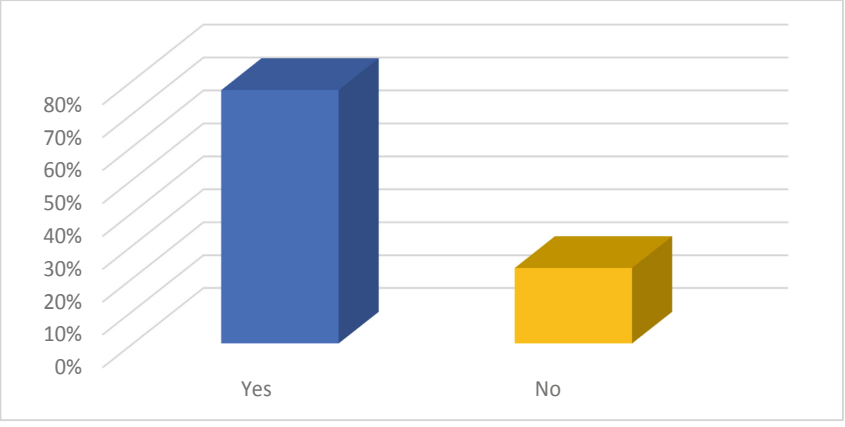

Fig. 1. Share of companies in Serbia which have/do not have controlling

The task of the logistics function is to integrate the activities performed by conventional departments (procurement, production, sales, etc.) in order to achieve an efficient flow of raw materials and finished products, with all related activities. Different types of performance are measured in different departments and at different levels where these processes are represented, and they often lack overall coordination. The question of great importance is to what extent and at what level it is possible - meaningfully - to create such an integrated system for measuring logistics performance.

In order to manage logistics processes, a controlling process is needed (Fig. 1). Its essence is to help the management in managing these processes or a certain group of processes. In practice, this means assistance in the management of functional areas, logistics processes and logistics projects. What is the role of logistics controlling? The main difference between logistics and controlling is in the aspect of business coordination. Logistics has a role in coordination of the service delivery system while controlling has the same role in the management system. How to combine these two functions in the company? Due to the increasing complexity of logistics processes, logistics controlling expands its area of activity and takes its place in the company.

4 Logistics Performance Monitoring – Model Proposal

Responsibility and commitment are usually measured through some kind of customer satisfaction and quality control of the logistics service. Hence we can divide performance to internal and external logistics processes. Internal and external performance are not new as concepts, but so far they have only been used when analyzing the performance of an entire company. Therefore, it is of interest to analyze how they can also be used at the departmental level when mapping logistics processes, something that has not been done before and a useful approach when describing and measuring logistics performance.

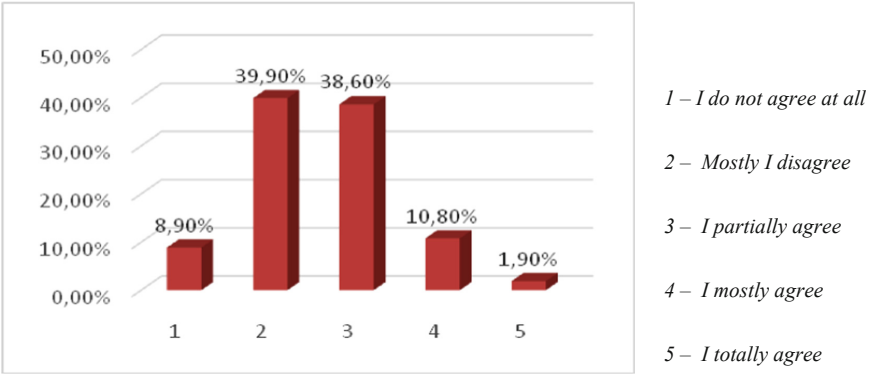

Fig. 2. Improving the quality of logistics services inevitably leads to increased costs?

Monitoring the efficiency of logistics processes is closely related to cost reduction, so often some processes are done because they reduce costs and not increase the quality of logistics services. To avoid this gap, we use the internal-external approach, ie the conflict of financial indicators and consumer expectations. By measuring and monitoring logistics performance and structuring it, we can balance internal and external expectations.

We tried to analyze whether the improvement of the quality of logistics services inevitably leads to costs increase based on a survey that included 187 employees, of which 55.7% were from manufacturing, 31.6% from service and 12.7% from other (combined) companies in the Republic of Serbia [3]. Most of the respondents did not

agree with that assumption. Only 1.9% believe that increasing quality inevitably leads to increased costs, and 10.8% partially agree (Fig. 2). Based on this, we can assume that increasing the quality of logistics service does not necessarily cause costs increase, if resources are managed properly and performance is taken into account. The condition for achieving that is successful and overall planning, not only in logistics but at the company level.

The proposed model for measuring logistics performance is based on external and internal approach to logistics processes (Fig. 3). Internal and external access can be summarized in the following logistics performances:

- Internal performance
  - warehouse (WH) management (materials and finish goods warehouses)
  - production management (ordering materials, stock management)
  - distribution management (transport and distribution)

The criteria proposed for monitoring internal performance are:

- logistics cost development (vs budget but also vs last year(s))
- log cost as % of CoS (cost of sales)
- resource efficiency (people, equipment,…)
- inventoryturnover
- obsolete inventory due to internal set up issues
- cost of capital (ROI)

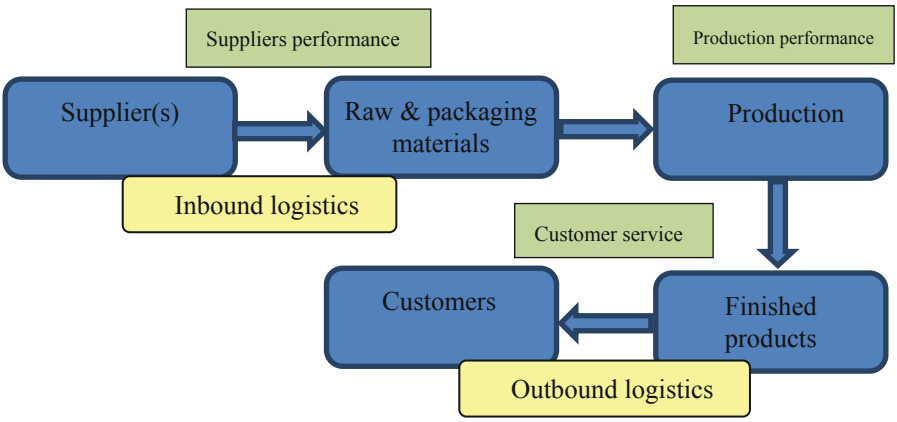

Fig. 3. End to end (E2E) internal and external process measurement

- Internal performance between different organizational units in the company
  - internal service levels (availability of materials and services)

  - reliability (quality and speed)

- External performance at the company level to suppliers and customers

  - reliability of suppliers (quality, quantity and lead time – ability to react)
  - proper SRM (supplier relationship management) process – villinges to constantly develop cooperation in different business areas [4].
  - customer satisfaction (on time in full delivery - OTIF, OSA – on shelf availabily, relationship satisfaction, etc.)
  - cost development in E2E (end to end) process (from supplier to customer)

Logistics is responsible for planning, implementation and control of storage, forward and reverse flows, with information sharing in E2E process. There is a need to measure how logistics performance is affecting total company performance, in order to evaluate its contribution to overall company strategy [7].

In addition to these proposed performance of logistics processes, the research concluded that the largest number of respondents believe that the health and safety of employees, together with employee satisfaction, is the most important perspective for measuring logistics performance.

Researchers mentioned the health and safety of employees as the most important performance of logistics processes, which is understandable, and this perspective has the greatest impact on employee satisfaction. In addition to employees, we also examined customer satisfaction as one of the most important stakeholders. The first question is who are the buyers of our products, whether they are companies, distributors, retail chains, restaurants or all together.

However, there are certain obstacles in raising the level of quality of logistics service, and in the research, we noticed that these are: lack of internal resources to achieve improvements, established way of working, resistance to change, etc. Most of the respondents believe that all factors contribute together and none of them can be singled out as special. The established way of working is one of the main obstacles for raising the level of quality of logistics services in as many as 70% of respondents. Resisting change is another obstacle and 82% of respondents believe that this is one of the reasons for not raising the quality of services.

Lack of understanding for market trends is a problem that logistics managers must work on and explain to employees in which direction the company should go and where it is now on that path, as well as the consequences if trends are not followed, if they cannot be created. The majority of respondents (68%) believe that employees in companies do not understand market trends or think that it does not affect their work (most believe they should work as before and that someone else should take care of market trends).

Important segment of the model is logistics network design. It has significant impact on cost structure, but also can influence on work force availability, service levels, lead times. When designing the network, it is important to gather relevant data from all functional areas within the company [5]. Among others, sales strategy is extremely important and it has huge impact on logistics set up. Depending on business development and market situation, there should be model evaluation every few years.

In order to have understandable performance measurement system, company has to create key performance indicators (KPIs) which are understandable – simple, with clear relevance, ownership and with not too many of them [6].

5 Conclusions

The essence of measuring the success of logistics processes is to achieve the highest possible quality and efficiency of logistics systems through all its constituent elements. Measuring the performance of logistics processes is significantly based on controlling instruments. By considering the operation specifics in logistics systems, this concept can be applied as a starting point for measuring their performance.

The paper shows that a large part of the issues associated with the measurement of logistics performance lies in the difference between traditional financial measurement and projected measurement of physical quantities. Financial measures are common as objectives and to control the company's activities at a higher level of management, while physical measures are used at the operational level to control the physical movement of products and materials.

The proposed model is a strategically oriented model and we think it would give good results in measuring logistics performance. It would be applicable in all industrial systems with eventual corrections and with a model description related to non-quantitative aspects, togehter with a defined methodology. In addition to reviewing the achieved results, the model would also serve to describe the logistics processes in the company. The model would serve for successful planning of logistics processes and thus for control of planned processes and realization of strategic goals of the company.

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Identification of Safety Indicators in the Manufacturing Industry in Republic of North Macedonia and Their Impact on the Occupational Injury Lost Time

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Abstract. The Constitution of the Republic of North Macedonia, in particular Article 32, paragraph 1, clearly states that "Everyone has the right to work, free choice of employment, safety at work and material security during temporary unemployment". The focus in the research is to contribute for reducing the lost working time in the companies in the manufacturing industry, as a result of occupational injuries and to increase the employee productivity and competitive advantage through development of safe working environment. The identification of the safety indicators is based on the analysis of existing scientific and research literary sources, OSH legislation in Republic of North Macedonia and Delphi method. The final result of the research is a developed methodology with structure of 50 identified safety indicators, divided into 14 groups. Each indicator is defined by a weight factor rated by the Delphi expert group based on its impact on reducing the time lost by the occupational injuries. The safety indicators are identified by reaching consensus of 32 occupational safety experts in two Delphi iterations.

Keywords: Safety indicators · Occupational health and safety · Occupational injuries · Manufacturing industry · Delphi method

1 Introduction

The World Health Organization (2018) statistical data [1], shows that a total of 7.500 workers die every day, of which 1.500 from occupational injuries and 6.000 from occupational diseases. Such statistical indicators worldwide, which present an increasing number of occupational injuries and diseases, indicate urgent need of preventive measures in the area of OHS worldwide, such as identification of safety indicators. A safe and healthy work environment directly affects and increases the motivation and confidence among employees and reduces the occupational stress by lowering the expectation that some kind of occupational injury will occur.

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 399–407, 2022.
http://doi.org/10.1007/978-3-030-97947-8_53

The Law on Occupational Safety and Health of the Republic of Northern Macedonia as well as the Directive 89/391/EEC [2] obliges all legal entities to conduct a risk assessment at each workplace, which regulates the obligations of employers, the rights and obligations of employees, occupational safety experts and OSH employee representatives. The analyses of occupational injuries in the manufacturing industry in Republic of North Macedonia (RNM) are presented only for the period from 2009 to 2012 [3] (Fig. 1), in absence of official statistical data regarding OSH [4]. The highest number of occupational injuries in RNM occurred in the construction industry, followed by manufacturing, health, traffic and other industries. However, the focus of occupational safety research on the construction industry, does not mean that other industries should be neglected, especially the manufacturing industry [5]. The situation in the manufacturing industry, in terms of occupational injuries, unfortunately is similar to the construction industry [6], having very high trendline that shows 2.8 times more occupational injuries in 2012 than in 2009. This positive trendline in the number of occupational injuries is due to the fact that the manufacturing industry is the largest employer in RNM, and thus statistically significant number of occupational injuries belongs to this industry. According the data in Fig. 1 there is a significant increase in the number of occupational injuries noted in 2012, which is an evident in the construction and manufacturing industry. Those data suggest that the workplaces in the construction and manufacturing industries are the most dangerous working places with the highest risk and possibility of occupational injury.

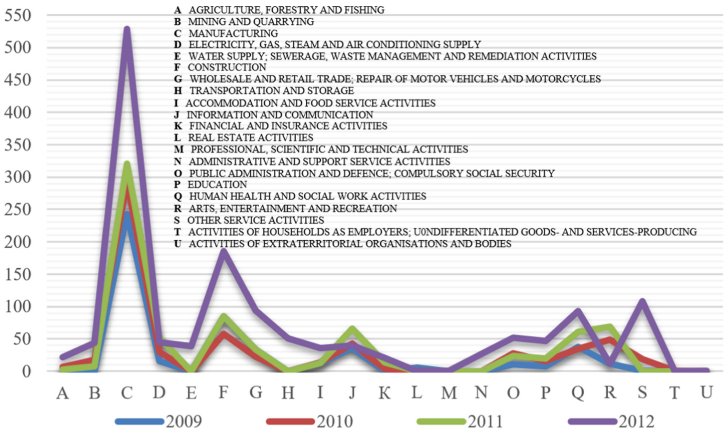

Fig. 1. Total number of injuries in the RNM in the period from 2009 to 2012 according to the National Classification of Activities, harmonized with the international NACE Rev. 2

If we analyse the cumulative number of injuries in the period of 3 years (2009 to 2012), then the results show that in the manufacturing industry there are total of 1386, and in construction 414 occupational injuries. These two industries together represent 54% of the total number of reported occupational injuries in the RNM for that period.

2 Literature Review

Through the research literature dozens of survey questionnaires have been developed in order to identify the key safety indicators [7–9]. Among the first, and definitely one of the most influential questionnaires, was developed in 1980 by the Israeli researcher Zohar [10] where in his research he determines eight safety indicators.

Coyle and his research team [11], also confirm in their extensive research, that there is no universal set of safety indicators that can be implemented in all industries at all working places.

The research conducted to determine the safety indicators that contribute to increasing performance in the manufacturing industry [12] and includes 30 occupational safety experts. These experts answer a 140-item questionnaire by conducting an assessment according to a five-point Likert scale. Safety indicators with the highest impact from the research are: management commitment, established OSH system, involvement of employees and their attitude towards OSH and the working environment, i.e. the climate for safety. The indicator of management commitment is one of the most important through the literature review, which in almost all researches where there is some hierarchy between indicators, is in the first place. In 88% of the analysed literature, it is presented and singled out as one of the most influential safety indicators for increasing the level of occupational safety and reducing the number of occupational injuries lost time. In some of the analysed literature [13, 14], the safety indicator for top management commitment is pointed out as the main indicator for increasing performance in the implemented occupational safety and health system.

3 Methodology

The methodology applied for collecting, systematizing and analysing the necessary data is a sublimate of applied qualitative and quantitative scientific research methods. In order to respond to the set of scientific research challenges, it is first necessary to make an analysis of the current situation and scientific research, as well as the legislation in RNM [15]. Through the application of qualitative research methods, analysis and synthesis group of safety indicators that are reducing the number of occupational accidents and increase the safety at work has been identified. The analysed safety indicators are further synthesized in order to prepare a list of safety indicators which is subject to additional research through a group of experts in the Delphi method. In the implementation of the Delphi method, a combination of different statistical methods is used, which contribute to the quantification of the questionnaire and setting of the weighting factors for each of the safety indicators based on their impact on the occupational injury lost time.

In the first step of Delphi method the selection of the expert group was based on special criteria developed by literary review from the results of related scientific research and recommendations. Those criteria comply the introductory questionnaire with a total of eight criteria, two of which are mandatory and six optional criteria. From the eight criteria defined, experts must meet two mandatory criteria and an additional three of the remaining six non-mandatory criteria, in order to be included in the expert group.

The introductory questionnaire was posted on an internet platform and sent to 86 occupational safety experts and answered by 65%, i.e. 56 respondents. From the answers

received from 56 respondents, only 41, i.e. 73%, meet the required criteria. Those experts composed a group of highly qualified experts in the field of occupational safety in the manufacturing industry. They analyse the safety indicators through two iterations and evaluates them by assigning an appropriate weight factor according to their impact on the occupational injury lost time. At this stage of the research, each expert has the opportunity to add or subtract a certain indicator, of course if a consensus is reached by all experts on such a decision. After each Delphi iteration, an analysis of the results is performed to check the consensus reached between the expert group, which out of 41 qualified experts, received answers in from 32 experts in all iterations. Expert consensus was reached in the second Delphi iteration, which is verified by the low level of the statistical indicators, coefficient of variation and coefficient of quarterly deviation.

3.1 Identification of Safety Indicators in the Manufacturing Industry

With the identification of the safety indicators in the manufacturing industry the model has been created as shown on Fig. 2.

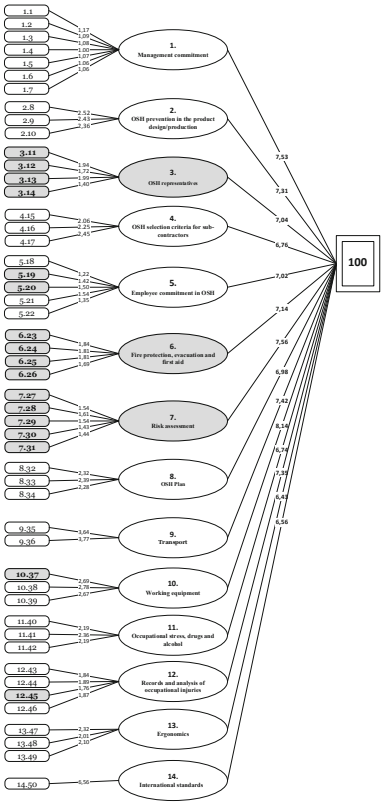

Fig. 2. Model of safety indicators in the manufacturing industry

According the scores obtained from the two iterations in the Delphi method, the sum of the mean values of the weighting factors provides a grading system with a total sum of 203.25 weight factor (WF). This large number of the total weight factor is due to the fact that the ratings of the experts in the Delphi method are given on the basis of a five-point Likert scale, from 0 to 5. For easier interpretation of the model results and its more efficient application in practice, the system for rating is normalized for its total value to be 100 credits (Fig. 2).

Based on the literary review of the existing scientific researches and the National legislation in the field of occupational safety and health in RNM, as well as the application of the Delphi method trough expert's assessment, a table with a list of safety indicators in the manufacturing industry has been created (Table 1).

Table 1. Safety indicators in the manufacturing industry

ID	Safety indicator	WF
1	**Management commitment**	**7,53**
1.1	OSH commitment of the manager/owner of the company	1,17
1.2	OSH commitment of the manager of production/technical manager	1,09
1.3	OSH commitment of the administrative chief	1,08
1.4	Additional/specialized OSH training for management	1,00
1.5	OSH meetings with employees	1,07
1.6	OSH meetings with top management	1,06
1.7	Meetings with employees when introducing new products, materials, technologies, tools and machinery	1,06
2	**OSH prevention in the product design/production**	**7,31**
2.8	Designing/constructing/developing technology safe for workers	2,52
2.9	Identification of hazards in the phase of construction/product design/technology design	2,43
2.10	OSH training for designers/constructors/production engineers	2,36
3	**OSH representatives**	**7,04**
3.11	Occupational safety expert	1,94
3.12	Employees occupational safety representative	1,72
3.13	Occupational safety expert is familiar with all hazards	1,99
3.14	Trade union representative is committed in the implementation of the OHS system	1,40
4	**OSH selection criteria for sub-contractors**	**6,76**
4.15	OSH selection criteria for sub-contractors	2,06
4.16	Responsible person for sub-contractor's control	2,25

(*continued*)

Table 1. (*continued*)

ID	Safety indicator	WF
4.17	Agreement with sub-contractors regarding the OSH standards	2,45
5	**Employee commitment in OSH**	**7,03**
5.18	During the process of selection of new employee, knowledge in OSH is evaluated	1,22
5.19	Employees have performed health examination	1,42
5.20	Employees attended training in OSH	1,50
5.21	There is an employee in every shift, authorized to stop the production process if potential hazard is identified	1,54
5.22	Measurement of the performance in OSH is part of the performance measurement system for managers/employees	1,35
6	**Fire protection, evacuation and first aid**	**7,14**
6.23	All safety measures against fire are adopted	1,84
6.24	Safety measures for first aid in case of emergency are adopted	1,81
6.25	Safety measures for evacuation in case of emergency	1,81
6.26	Agreement with a health institution in the field of occupational medicine, with legal entity specialized to provide first aid services, emergency medical assistance for activities in evacuation and rescue and fire protection	1,69
7	**Risk assessment**	**7,56**
7.27	Risk assessment and hazard analysis from authorized legal entity for performing occupational safety services	1,54
7.28	Work environment assessment	1,61
7.29	Hazardous substance management plan	1,54
7.30	All OSH measures have been taken for employees under 18 years old and over 57/59, pregnant women, employee with a sick child and a single father parent	1,43
7.31	Warnings and signs for potential hazards are properly set at the workplaces and at the working equipment (according the act for OSH signs)	1,44
8	**OSH Plan**	**6,98**
8.32	The production plan (capacities, normative, timeline) harmonized with the OSH system (based on the principle to reduce the risk)	2,32
8.33	Program for planning measures and means for providing development and improvement of OSH system	2,39
8.34	Plan for maintaining clean working environment (with activities and responsibilities)	2,28
9	**Transport**	**7,42**
9.35	Measures for safe external transport (outside of the company) speed limit, and GPS tracking of the means of transport	3,64
9.36	Measures for safe internal transport, machines and vehicles	3,77
10	**Working equipment**	**8,14**

(*continued*)

Table 1. (*continued*)

ID	Safety indicator	WF
10.37	Working equipment (machines and tools) are safe for the operators	2,69
10.38	Machine operators have the appropriate qualifications	2,78
10.39	There is a procedure for maintenance of the working equipment	2,67
11	**Occupational stress, drugs and alcohol**	**6,74**
11.40	Occupational stress reduction program, action plan for stress prevention (discrimination, violence, bulling, mobbing, burning syndrome)	2,19
11.41	Alcohol testing program	2,36
11.42	Drug and drug substances testing program	2,19
12	**Records and analysis of occupational injuries**	**7,35**
12.43	Keeping records of every incident and "near miss"	1,84
12.44	Analysis and research of every incident and "near miss"	1,89
12.45	Keeping records (legal obligations according to the legal act)	1,76
12.46	Effective internal OSH inspections	1,87
13	**Ergonomics**	**6,43**
13.47	Ergonomic analysis of working activities and their appropriate adaptation	2,32
13.48	Employees ergonomic exercises program	2,01
13.49	Ergonomic principles for reducing monotone and repetitive movements	2,10
14	**International standards**	**6,56**
14.50	Implementation of International standards	6,56

This list of safety indicators (Table 1) contains 50 indicators distributed in 14 main groups. Out of the total number of 50 safety indicators that have been identified, 34%, i.e. 17 indicators arise as a result of the legal obligations for OSH (marked in bold and grey on Fig. 2).

4 Conclusion

Safety indicators which affect the reduction of occupational injury lost time, have been identified according to the developed research methodology, through the analysis of existing data from various sources. Those safety indicators are identified through: the analysis of the existing literature, with the results from the scientific papers in the field of OSH, the legal obligations in accordance with the national legislation on OSH in the RNM and the implementation of Delphi method. The result of the research is a list of identified 50 safety indicators, distributed in 14 groups.

In the results of the Delphi method, the largest weight factor assessed by Delphi experts is the group of indicators related to the working equipment. Such results are expected, given that the research addresses the manufacturing industry where machinery

and tools are one of the leading causes of occupational injuries. The next two groups according to the weight factor obtained by the experts in the Delphi method are: risk assessment and management commitment. Risk assessment is a legal obligation, in accordance with national OSH legislation and is the basis of all OSH systems for hazard identification, which contributes to specific risk mitigation measures. The management commitment, as a group of indicators in this research is assessed with a high weight factor, that confirms the literature review analysis with the same results showing highest impact on this safety indicator.

From the research results and analysis, data are obtained on the critical points of certain OSH systems, which is the basis for corrective measures and upgrading of the system. This opportunity for self-evaluation and comparison of OSH systems in relation to other legal entities in the processing industry, enables the sustainable development of OSH systems.

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Innovativeness of Micro and Small Enterprises – Are Their Innovation Drivers Different?

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Abstract. In the second half of the 20th century the labor cost, along with the level of industrialization, was considered to be the fundamental competitiveness factor. In today's competitive business environment, innovation is the vital ability and activity for firm's sustainability. Although the innovation is widely examined in the literature, further research is needed in this field to address the factors which determine the innovativeness of micro and small enterprises. The purpose of this research was to fill in that gap through development and implementation of a methodology for modelling of the innovativeness of micro and small enterprises. The first step is the analysis of the relevant literature and mapping two types of factors that are widely discussed: influencing factors – supporting innovation and influenced factors. The conceptual model that was developed based on these findings is refined through structured interviews of 18 experts from different stakeholders in the innovation ecosystem, and from different regions. The refined model was validated through 150 quantitative interviews with micro and small companies in the Northeast region of North Macedonia. The following factors were validated as most influential in the analyzed region: the openness of the company, the identification of the employees with the company, communication, owner's profile, educational diversification of employees and encouraging employees to propose innovation. The methodology and the models offer significant input into future research, in the development of analytical tools on macro level, as well as for modelling of innovativeness on company level.

Keywords: Modelling innovation · Innovation of micro and small enterprises · Factors of innovativeness · Measuring innovativeness · Innovation ecosystem

1 Introduction

Innovations are the main enabler of competitiveness and driver of development, particularly in the knowledge based economies. In the last decades, many developing economies

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 408–416, 2022.
http://doi.org/10.1007/978-3-030-97947-8_54

has strongly emphasized them as one of the key actions in their transitional strategy. Innovations are considered to be one of the most progressive determinants of socioeconomic growth, both in regional and local perspective [1]. High levels of innovativeness have a positive influence on performance at the firm level [2] and, as a result, on economic performance at the regional or national levels as well [3].

The innovativeness is a crucial aspect for development and competitiveness of micro and small enterprises (MSE), and through them of the respective economies. This notion, along with the presented lack of literature for its understanding imposes the need to select, define and measure the factors influencing the innovativeness of MSEs. The state model of North Macedonia, as many former socialist countries, resembles to the triple helix. However, the state has a governing role in the collaboration between the three main spheres of the society [4, 5].

The lack of acknowledged systems for measurement of innovation, requires additionally focus on the factors influenced by the innovation activities and results. On the other hand, the impact of the innovation ecosystem on innovativeness of the firm, imposes validation of the model in a specific ecosystem, requiring systematic approach for selection of both influencing and influenced factors.

2 Literature Review

The factors for innovation of micro and small enterprise are the essence of this research. To offer a comprehensive overview of the relevant factors, two main categories of influencing factors have been identified and further analyzed: *(I) Entrepreneurial attitude and internal ecosystem*, and *(II) Innovation process.* These two categories are divided into three (*A. Overall setting; B. Culture and C. Knowledge management*) and two (*D. Collaborations and external support* and *E. Procedures and regulations*) smaller groups of factors, respectively. Influenced factors are presented as category *(III) Innovativeness*, grouped into two groups (*F. Introduced innovation* and *G. Growth*). In this paper, only a selection of the literature review is presented.

2.1 Factors Influencing Innovativeness

Numerous general factors significantly influence the innovativeness of the enterprises, such as: the main sector of operation, the geographic market that is targeted, the strategic planning within the company and its corporate success, estimated through the financial results, growth in portfolios and growth in number of employees, as well as the environmental impact. Many studies have shown that the culture of the company is one of the most important factors for innovativeness. It is discussed that openness to change influences the way how early ideas for innovations are screened and approached within the company [6]. Aloulou and Fayolle [7] consider "especially organizational culture, the nature of its climate and its practices of management" (p. 29) as a central antecedent of entrepreneurial orientation. Entrepreneurial orientation in smaller firms (start-ups and SMEs) mostly originates from the owner's profile. The openness in the companies, proposes that firms should purposively use inflows and outflows of knowledge to accelerate internal innovation, and to expand markets for external use of innovation [8]. External

knowledge sourcing requires internal capabilities in order to (1) integrate inflows of knowledge with internal innovation activities, (2) successfully apply knowledge from internal and external sources, and (3) direct innovation actions [9, 10].

The internal ecosystem and culture, along with the innovation process is developing the company's innovativeness. This process is affected by collaboration with external partners on one hand, and the procedures and regulations for managing of innovations internally, on the other. Developing partnerships for innovation is particularly with larger companies is essential for SMEs competing in global business-to-business (B2B) markets [11]. However, for SMEs such collaborations may encounter various challenges [12, 13], such as identifying suitable customers for collaboration [14], and developing trusting relationships with customers [15].

2.2 Factors Influenced by Innovation

Measuring innovation in a company is not unambiguously defined in the literature. Innovation is often associated with the level of improvement of the relevant goods or services, which is arguable since the innovation project does not necessarily result in an increased product competitiveness [16]. The innovativeness shows the company's ability to be receptive to new ideas and their acceptance, which leads to the development and launch of a new product [17, 18]. Subramanian [19] notes that enterprise innovation is perceived differently depending on the research approach.

Introducing different types of innovation improves the survival of companies, confirming the old adage: "innovate or die". In addition, innovative firms need to introduce different types of innovation addressing multiple aspects of the organization [20, 21].

The growth of companies is one of the most frequently analyzed factors influenced by the innovation of the company. Colombelli et al. [22] analyzed level of innovation in the French industry, in the period 1992–2004, suggesting that innovative firms grow more than non-innovative ones. Mansfield [23] analyzed 10 companies and aggregates of 10 different industries in the United States from 1916 to 1954. The main conclusion was that companies which have implemented significant innovations are growing faster. A panel survey of 500 manufacturing companies in Italy (1989–1997), analyzed the operating profit margins, showed connection between growth and intensity of research activities [24]. The same conclusion is reached in the public sector [25]. Almost simultaneously (1998–2004), research in 95 semiconductor companies worldwide, showed that company growth and total sales are positively affected by the number of product innovations [26]. This additionally shows the lack of consensus on the factors influencing the innovativeness, emphasizing the importance of systematic approach in determination of the influential and influenced factors.

The innovations introduced in the company can be evaluated by assessing the perception of the management, the level of innovation, the connection of innovations with the key competencies of the company, as well as through variety of introduced innovations, patents and other forms of intellectual property. The direct impact of innovation on firm growth can be identified by tracking profits and revenue.

3 Research Methodology and Model Creation

The research has been designed as a three phase process. Initially, a wide set of relevant factors for innovativeness for micro and small enterprises, are identified throughout the analyzed relevant literature. The developed draft conceptual model was used as a base for development of the draft guidelines for the structured interview with the experts. This guideline was tested through two pilot interviews with relevant academic experts (one from North Macedonia and one foreign) in order to assure that: (1) there is no lack of significant factors or a factor redundancy, and (2) the chosen factors and their respective descriptions are clear, precise and significantly detailed.

Based on the interviews two factors were added to the draft conceptual model and several factors were further defined, resulting with the final **conceptual model** (Fig. 1).

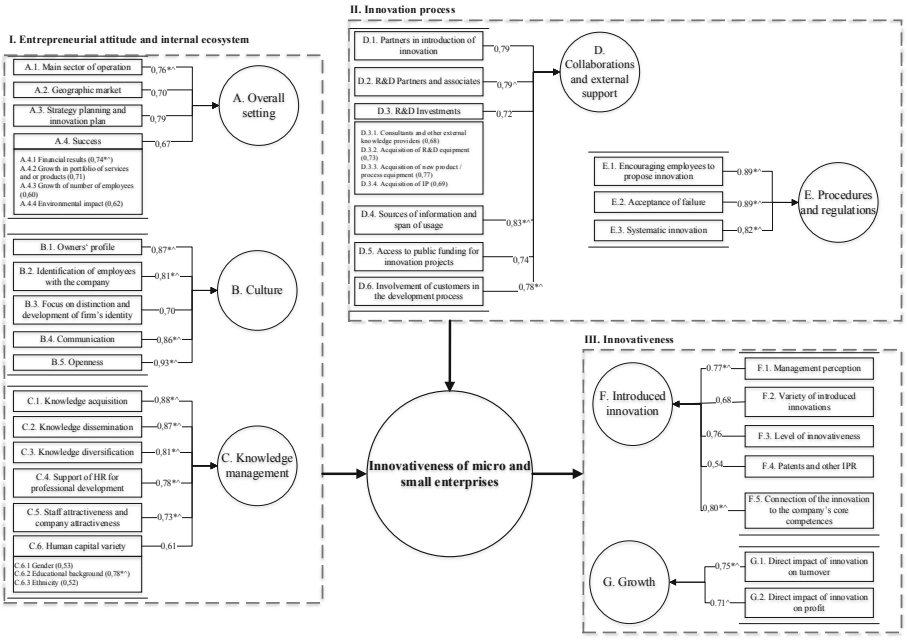

Fig. 1. Conceptual model of the factors for innovativeness of micro and small enterprises

The second phase is the development of the **refined model**, evaluating the conceptual model through 18 structured interviews conducted with experts in the period summer - autumn 2016. The experts have been clustered in three professional categories: (1) Academia, (2) Business support organizations (BSO) and (3) Entrepreneurs in two geographic categories: (1) North Macedonia and (2) foreign. All identified experts from academia and BSO fulfil the strict entry criteria: topic – expertise in the area of innovation of micro and small companies; experience – more than 10 years' related experience; and education – second cycle higher education (master) or higher. For the entrepreneurs: the minimum required education first cycle higher education (bachelor),

and it was assured that the company established and managed is clearly recognized as an innovative company. The detailed methodology for the creation of the refined model (Fig. 2) is presented in Jovanovski et al. [27].

In the model **validation phase**, for each factor at least one indicator (statistical variable) is created. In order to cover all main aspects of the factor, some of these variables are receiving values from multiple questions. The factor which could not be validated with quantitative analysis, have been validated though an in-depth interview.

Qualitative Factor Validation

Based its nature the factor *B.1. Owner's profile* is not suitable for quantitative analysis, which was also confirmed by the experts during the interviews. Thus, this factor was validated through three hours' in-depth interview with an entrepreneur. The selected interviewee is an owner of three companies, two connected vertically in the supply chain, and one in a different sector.

Based on the interview it was concluded that the capability of the owner to track business opportunities, combined with the skill for foreseeing future challenges and the determination for creation solution for these challenges is one of the key factors for business success. His strong leadership is influential throughout the company with a main focus on development of creative atmosphere, making all sectors in the firms innovative. Thus, the influence of the owner over the innovativeness is clearly notable through the development of communication, acquisition and dissemination of knowledge and experiences, identification of employees with the company, encouraging employees to propose and implement innovation projects, as well as including external experts.

Quantitative Factor Validation

The quantitative validation was conducted based on primary data (face-to-face survey of 150 micro and small companies), in order to decrease the influence of the external factors (local labor market, infrastructure, etc.), collected in a single micro-region.

In the refined model three most significant factors influenced by innovation have been selected. In order to validate the model using statistical analysis based on multiple regression, statistical model, or a sub-model was created for each of them.

Comparison of the Parameters of the Statistical Models

The three statistical models are significant with R^2 values 0,631, 0,706 and 0,632 respectively, providing models which explain 63,1%–70,6% of the change in the dependent variables. Throughout the models, 6 factors had confirmed significant relation, out of which three have been confirmed in at least two of the models (Table 1). Such harmonization of results may indicate selection of substantial influencing factors and influenced factors which capture the key results of the innovation activities.

The regression model of each of the three dependent variables was significant, thus the three analyzed regression models composed the validated model. Given that the sub-models as a whole were significant, the validated model is composed of all factors of the validation sub-models (statistical models), expanded with the factor validated through a qualitative in-depth interview. Based on that the validated model comprises all the factors included in the refined model. The only difference appears with factor C.6.2.

Education, which due to its complexity, in the validation phase was analyzed as two separate factors: C.6.2.1. Education (Level) and C.6.2.2. Education (Field).

Table 1. Overview of the validated factors and their relations with the dependent variables

	Dependent variables (R^2 of the model)		
Factors validated through the model of the respective dependent variable	F.1._Management_perception ($R^2 = 0{,}631$**)	F.5_Inno.core.competences ($R^2 = 0{,}706$**)	G.1._Dir.inf.turnover ($R^2 = 0{,}632$**)
B.2. Identification of employees with the company		✓**	✓*
B.4. Communication			✓*
B.5. Openness	✓*	✓**	✓*
C.2. Knowledge dissemination	✓*		
C.6.2.2 Educational background (Field)	✓**		✓**
E.1. Encouraging employees to propose innovation		✓**	

** Significance $p < 0{,}01$
* Significance $p < 0{,}05$

Although, the refined model was validated as a whole, the statistically significant impacts of the factors are reported in the validated model (Fig. 2):

Not-validated Individual Relations
Influential factors whose coefficients in all regression models are statistically not significant, are presented with a dashed line.

Validated Individual Relations
Influential factors whose individual relation are validated in at least one sub-model, are indicated by ticker lines and bold text. It is stated which sub-model(s) and at what level of significance were used, or that it is validated through the in-depth interview.

Dependent Variables
The influenced factors are indicated by a full thin line. The statistical significance is stated of the regression model with which they were validated.

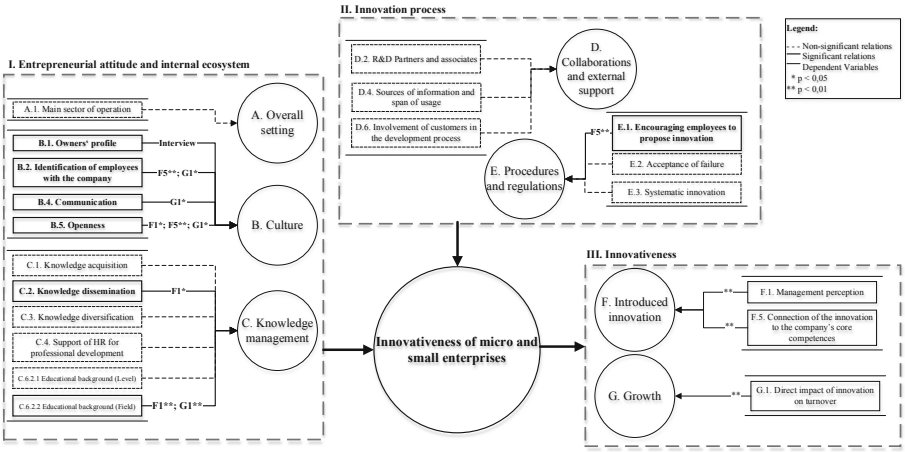

Fig. 2. Validated model of the innovativeness of micro and small enterprises

4 Conclusion

The models for innovativeness of micro and small enterprises play an important role in understanding of the innovativeness with particular focus on MSEs. **The conceptual model**, with the literature analyzed and structured for its development, represents an important synthesis of the contemporary global literature of factors for innovativeness, providing a comprehensive overview. **The refined model** presents the most influential factors for MSE innovation, as well as factors and indicators for measuring it (influencing factors). Thus, closing significant research gap in the global literature. The results of the survey of micro and small enterprises, in addition to the **validation of the model**, which has universal significance, contribute to the understanding of the driving forces of innovation in micro and small enterprises in the Northeast region of Republic of Macedonia, and indirectly across the country. As the only research of its kind it is very significant for the country, as well as for countries with similar economic development.

On factor level, this research stresses the importance of the culture of the MSE presented through the entrepreneurial, innovative and open-minded spirit of the owner(s), a dynamic team identifying themselves with the firm, which is open to ideas, suggestions and changes, with extensive internal and external communication.

Policy makers and **entrepreneurs** can use the framework for setting up an Innovation Measurement System for MSEs, as important support for identifying weaknesses in innovation systems, as well as for selecting priority targets to increase competitiveness at enterprise and/or specific ecosystems level.

For the **researchers** in the field, this research offers a comprehensive overview of the factors that influence and are influenced by the innovation of micro and small enterprises. Through the models and methodology, platform for additional research of the innovation of the enterprises with other characteristics or in other ecosystems.

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Responsible Research and Innovation in Industrial Systems – An Overview and Implications for Companies Who Strive to Work for and with Society

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Abstract. "Responsible research and innovation" (RRI) is an approach that anticipates and assesses potential implications and societal expectations concerning research and innovation, intending to foster the design of inclusive and sustainable research and innovation. Particularly close cooperation between all stakeholders is expected in these aspects: science education, public engagement, access to research results and the application of new knowledge in full compliance with gender and ethics considerations.

In the business world where competition is harsh, contracts are often short termed, and productivity is celebrated, there is an open question where does the "society" fit in? In a context that often observes "return on investment" as the main criterion for decision making, societal needs are always challenged to make and keep their place.

This paper aims to explore the industrial perspective on RRI principles by presenting an overview in this field, current knowledge and limitations. Especially, the motivation of the industry to think in RRI terms is observed. Finally, conclusions are driven that may allow companies to better understand why and how to include society in their R&D processes.

Keywords: Responsible research · Responsible innovation · Industrial systems

1 Introduction and Rationale

Responsible Research and Innovation (RRI) is a relatively new term used to describe research and technological development processes that take into account effects and potential impacts on the environment and society. While there are slightly different definitions available, the basic assumption of RRI is that societal challenges should be a primary focus of scientific research, with methods that are mutually agreed upon; basically, RRI acts as a key "approach to mediating the relationship between science and society" [1].

There is no doubt that research and innovation (R&I) are key drivers of both economic changes and social changes around the world. Whenever there is a significant challenge

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 417–424, 2022.
http://doi.org/10.1007/978-3-030-97947-8_55

or a prosperous chance, science will try to find the best solution, and innovation will present it to the market. Frequently, this will allow progress to all interested parties: the society, business owners and policy makers. However, there are numerous scientific breakthroughs and innovation successes that have had significant negative impact on the society, or on the environment. Some research, such as embryology research or genetically modified crops have raised serious issues in the society, while, furthermore, other innovations have been directly used to inflict harm to human beings or the environment. It is, therefore, a relevant point to raise question of responsibility in R&I activities, and also to carefully consider the impact of R&I on the society.

In the heart of RRI approach is a two-way dialogue between science and the public: mutual understanding is needed to build science and innovation in such way that it can truly reflect wider social needs and values. However, both the ambiguity of the RRI as an "umbrella term" and the lack of specific suggestions for implementation pose significant challenges for this approach, with frequent scepticism being expressed about RRI usability and even its content [2]. While there is a significant and constantly growing body of literature available related to RRI in the scientific realm, less attention is diverted to the commercial context. Values and expectations are often found to be quite different in industry settings, where a dialogue with society may be observed (at least in the short term) as unnecessary, non-efficient, or even counterproductive from the capital's point of view. Therefore, this paper explores RRI in the perspective of industrial systems, aiming to contribute to implementing the RRI practices to this context.

2 RRI Development Support and the Resulting Tools

RRI represents European framework for ethics in research processes, which has historically developed from conducting ethical tracking in scientific fields like nanotechnology and genetics. As such, this framework aimed to provide a frame in which science and innovation are supported – a frame relevant and understandable to the non-scientists and the general public. RRI principles have been promoted through the EU funding programs of scientific projects [3], but these projects have been frequently challenged to provide conclusions and implications for non-scientists.

The relationship between scientific projects and EU citizens was explicitly supported through these framework programs:

- FP6 funded projects on 'Science and society',
- FP7 prioritized closer integration with 'Science in Society',
- Horizon 2020 supports the 'Science with and for Society' better known as SwafS.

During the Horizon 2020, the SwafS was promoted through eight lines within three work packages (SwafS WP 2014–2015, SwafS WP 2016–2017 and SwafS WP 2018–2020) [4]:

- The attractiveness of scientific careers;
- Gender equality;
- Integration of citizens interests and values in research and innovation (R&I);

- Formal and informal science education;
- Accessibility and use of research results;
- Governance for the advancement of responsible research and innovation and promotion of an ethics framework for research and innovation;
- The anticipation of potential environmental, health and safety impacts;
- Improved knowledge of science communication

According to the available data [4], the number of SwafS proposals received, evaluated, and funded during the Horizon 2020 is shown for each year, as seen in Fig. 1. A positive trend in the number of funded projects is obvious. Project proposals applicants were from all parts of the quadruple helix model [4].

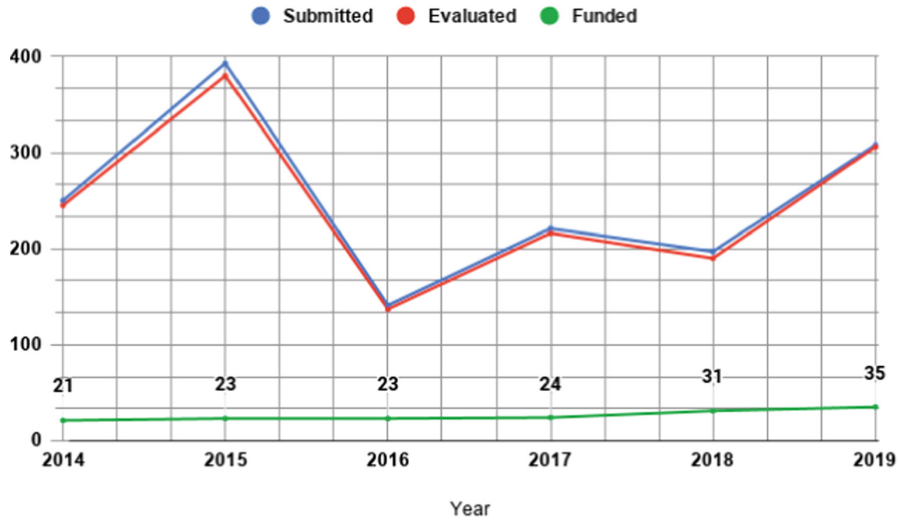

Fig. 1. SwafS statistics in the Horizon 2020 for project proposals between 2014 and 2019 (data source from [4])

What are the benefits of RRI oriented projects? In [5] the RRI benefits are divided into four categories: societal (alignment of research and societal needs), democratic (empowerment of citizens, better-informed decision-making), economic (better performance, data collection is more cost-efficient, new business opportunities, etc.) and scientific (data access, new skills, and training activities for researchers, better performance, etc.). In [5] examples of RRI benefits can be found:

- Integration of fishermen into research processes for the management of fisheries and the environment with methods like workshops, networking events, surveys, focus groups, etc. This empowered fishermen with knowledge and enabled them to be included in policymaking processes and positively influenced the sustainable production of the fish (democratic and economic benefits).
- Investigation of innovation processes in the manufacturing industry in 2700 manufacturing companies has shown that manufacturing companies that apply responsible

practices are more innovative and have a better chance of being more competitive on the market with new products and services (economic benefits).

In order to RRI be better included in research and innovation processes, it is also important to define the ways of measuring the mentioned benefits. It is essential to develop a set of performance metrics and indicators. The EU funded projects for RRI benefits monitoring are MoRRI (http://morri-project.eu) and Super MoRRI (https://www.super-morri.eu/super-morri/index.php).

EU funded project RRI tools (www.rri-tools.eu) represents a good knowledge base for implementation of RRI within the Horizon 2020. Here, numerous tools have been developed and presented to help practitioners in implementing RRI in their activities. This project delivered a detailed toolkit for applying RRI concepts and strategies in particular contexts and within specific areas; also, it provides a guide for self-reflection, thus stimulating and offering inspiring ideas for R&I practices.

All of these efforts result in a significant change towards being more responsible. Specifically, in [5] the proposed RRI benefits indicators are grouped as:

- Intermediate (participation of citizens in research processes, and also two gender equality indicators),
- Modelled on pathways from RRI outcomes to benefits (access to open data, training of researchers in public communication, citizens understanding of science and technology choices, gender relevance of research outputs, etc.),
- Network (degrees of diversity and coherence in research networks).

3 RRI in the Business Context

When it comes to implementing RRI in any kind of business, the main point that should be considered is – what does it mean to be responsible? For a long time, primary interest and responsibility of any business was to make profit without much consideration for other perspectives. Then, a discourse on the extension of business' responsibility to stakeholders and broader society started to emerge in the 1950s and 1060s, with scholars such as Howard R. Bowen and Peter Drucker who discussed moral and ethical responsibilities of a business [6]. Here, terms such as business ethics, corporate social responsibility, and corporate sustainability were conceptualized.

At first, the industry perceived responsibility as an additional activity - the act of "giving back" to the society, which resulted in corporate events and actions that were not closely related to the core business [7]. Here, industry was simply letting go of an insignificant percentage of its profit to support public interests, in order to show its philanthropy (or even to qualify for a tax reduction, compensate for maltreatment of workers, or to make up for a possible environmental pollution). Later, with globalization and unprecedented technological growth, more and more companies realized that the responsibility towards society could become a strategic approach. A shared value could be created if the companies were to act responsibly and to address societal needs, thus serving economic and societal responsibility at the same time [8]. The highest achievement here is actually to adopt business responsibility as a core of business strategy – creating products and services that are responding to societal needs, and doing

so while experiencing business growth. Therefore, the term "corporate sustainability" suggests that "responding to societal needs and acting responsibly towards people and the environment is a precondition to business survival" [7]. In the following two chapters, research and innovation activities will be observed separately [9] in the industrial context.

3.1 Responsible Research in Industrial Systems

It is universally known that research activities produce new knowledge that is necessary in order to innovate in the near future. Across different industries, companies conduct research to produce new products or offer better services, and these research processes are more or less regulated depending on the subject of research. While research institutes and academia usually have relatively straightforward ethical rules of conduct, in the industry there are additional factors that may influence research processes, especially in the area of applied research where aspects such as return of investment, profit, and market share are significantly sought after.

It the case of research, responsibility is often linked to a commitment to integrity, where values of transparency, compliance to regulation, rigorous peer reviews, and embedding societal considerations into research programmes are promoted [9]. Industrial research should aim for the same values in order to qualify as "responsible".

3.2 Responsible Innovation in Industrial Systems

Historical foundations of responsible innovation are built on discussions and debates concerning the social responsibility of science that go back many decades [10]. Dreyer et al. [9] argues that the four building blocks the RRI framework anticipation, reflexivity, inclusion and deliberation, and responsiveness, proposed by Stilgoe et al. [11] exist in innovation management, and that some RI practices in industry are well established and mature. Anticipation can be linked to the Business model generation and risk analysis, reflexivity can be related to the audit of practices and compliance, such as ISO for quality, environment, safety, and others. Inclusion and deliberation can be related to the front-end activities in innovation management. Responsiveness can be related to the requirements of Agile project management [9].

Lubberink et al. [12] argues that social and sustainable innovation share conceptual similarities with responsible innovation when it comes to their input, throughput, and output of innovation as social and sustainable innovation aim to respond to overarching societal challenges, they require the involvement of multiple stakeholders, and they consider social and environmental impact as desirable innovation outcomes [12]. In the next section we will explore in more detail the input, throughput and output of responsible innovation processes.

The input for responsible innovation processes is often found in in the so called 'grand challenges' of our time; climate change, resource depletion, poverty alleviation, ageing societies… [13], where various stakeholders have different ideas about the problem and its solution in general and about the societal and ethical aspects which have to be taken into account during the innovation process in particular [14]. Profit and non-profit organizations have divergent approaches to value creation, one will focus on economic value

creation, while others may focus on social value creation. This fundamental differences among stakeholders with regard to their vision, goal, sector and motive, indicate that it is not so easy to 'incorporate relevant ethical and societal aspects' so that 'technological and scientific advances become properly embedded in society', as is sometimes suggested in the literature [15]. Power imbalances among stakeholders as some actors are more powerful than others in defining the problem and the objectives of the innovation process, can be seen as a prime source of conflicts among stakeholders [16].

The throughput of the responsible innovation process should be characterized by transparency, interaction and mutual responsiveness [13], it is expected that partnerships between companies and their stakeholders "jointly achieve an outcome that could not be achieved by organizations in one sector alone" [16]. In order to incorporate relevant ethical and societal aspects in the innovation process, various technology assessment approaches have been developed that assume stakeholders involvement 'right from the start' [17]. Innovation processes is the strong source of competitive advantage that enables companies to react to business opportunities in the market, and collaborations with stakeholders throughout of the innovation process are sometimes explicitly restricted, especially in case of intellectual property (IP) and secrecy. Innovation process is highly uncertain and involve high amounts of investment, during that process and with all the unforeseen things that can happen stakeholders have to cooperate constructively and live up to the commitments they made at the beginning.

The involvement of stakeholders doesn't necessarily guarantee a more responsible output of the innovation process. For example, increased demand for renewable and less polluting biofuels increased food prices, although stakeholder involvement may result in more desirable outcomes. Innovations are uncertain and that their societal and environmental consequences are unpredictable [18]. Our knowledge is principally insufficient to assess the impact of innovation processes and there will always be unintended consequences of our innovations which can be harmful. According to Joseph Schumpeter, the founding father of innovation, the construction of new and innovative solutions is accompanied by the annihilation or destruction of the old rules and the old order (including the 'writing off' of 'obsolescent' skills, technologies and capital stocks) [19], so the positive impact of responsible innovation and contribution to the public good, is accompanied by negative impacts elsewhere.

The analysis of the input, throughput and output of innovation processes pointed at several difficulties that undermine the responsible character of innovation processes. Regardless, successful examples of implementation of guiding RRI principles in business practice can be found. European Union's RRI Tools project put together eight showcases that exemplify how RRI can be applied in practice from a UK company Hao2, which works to develop novel solutions that empower people on the autism spectrum to find employment and Knowledge for Climate Programme, which brought together researchers, businesses and citizens to understand climate change to the efforts of Portuguese Sea and Atmosphere Institute to maintain the livelihood of local fishers, marine biodiversity and sea conservation [20].

4 Conclusion

This paper aimed to explore RRI in the perspective of industrial systems, with the aim to contribute to implementing the RRI practices to this context. The EU did invest heavily in promoting and implementing RRI as wide as possible, but experience shows that most of the assets were employed in theoretical research, societal changes or policy interventions. While there are a few successful examples of implementation of guiding RRI principles in business practice, in general this challenge is still open and with multiple issues. One promising venue could be if the companies were to adopt business responsibility as a core of business strategy – creating products and services that are responding to societal needs, and doing so while experiencing business growth.

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Analysis of the Prediction Quality of Technology Developments Based on Gartner Hype Cycles for Emerging Technologies

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Abstract. Companies spend a lot of money on advice and reports from consultancy companies. Gartner is one of these companies, which publishes regularly the Gartner Hype Cycle for Emerging Technologies. Gartner wants to support companies to recognize when new technologies make promises. How is it possible to "discern the hype from what's commercially viable? And when will such claims pay off, if at all?" Missing a trend or investing in a non-prevalent trend will have a negative impact on companies. However, how good is the prediction quality of the Gartner Hype Cycle? Therefore, we analyzed the Gartner Hype Cycles of the last 15 years. We analyzed different aspects, e.g. the occurrence of technologies in the hype cycles of different years and the prediction of the phase curve of technologies. We found out that many technologies appear only once in the hype cycle and disappear quickly. We did not analyze these technologies more in detail. We looked only at technologies, which appear at least twice. From these technologies round about one third show 'inconsistencies' in the considered aspects.

Keywords: Gartner hype cycle for emerging technologies · Technology development · Prediction quality

1 Introduction

Nowadays, it is not only for companies, but also for universities and research centers important to realize future trends of emerging technologies [1–4]. One instrument to do this is the Gartner Hype Cycle for Emerging Technologies [5]. An instrument like this is necessary because prognosis on technologies, which are relevant in the future, are complex and costly to prepare [4]. Therefore, there is a risk that the development of technologies may be misjudged. Misjudgments can occur in various forms. In industry

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 425–432, 2022.
http://doi.org/10.1007/978-3-030-97947-8_56

for instance, misjudgments lead to wrong strategic decisions, in research centers, consequences are wrong research focusses [6]. That is why many companies and research centers rely on the accuracy of prognosis of Gartner. The goal of this paper is to measure, to evaluate and to analyze the quality of the prediction of emerging technologies by Gartner. We analyze in the following paper the accuracy of the predictions of Gartner's Hype Cycle for Emerging Technologies between 2005 and 2019. Therefore, we analyze the accuracy and meaningfulness of predictions regarding the temporal and existential availability of technologies. With the results of our research, we want to provide advice to decision makers on how to rely on Gartner's Hype Cycle for Emerging Technologies when pursuing new technologies. Previous research on the accuracy of Gartner's Hype Cycle for Emerging Technologies has shown that there are inconsistencies in the forecast of technologies. However, Dedehayir and Steinert considered only the period from 2003 to 2009 [7]. For long-term technological trends the consideration of a period of seven years is too short.

At first, the Gartner Hype Cycle for Emerging Technologies is characterized. After that, the methodology is described, before we analyze and discuss the findings. This paper ends with a conclusion and outlook for future research.

2 Gartner Hype Cycle for Emerging Technologies

Gartner is a global research and consulting company, which offers analyses of developments of new technologies [8]. Amongst other research results, Gartner offers the Hype Cycle for Emerging Technologies yearly [7, 9]. The Hype Cycle for Emerging Technologies is a graphical presentation of the life cycle of technologies. It allows having an overview on the state of the development of new technologies. The Hype Cycle offers a support to decision makers to evaluate and estimate the potential and the relevance of technological trends [7].

While the x-axis shows the phase of maturity, the y-axis shows the expectations in a technology. Gartner divides the development of a technology in five phases. These phases show the maturity of a technology [11]. These phases are 1. Technology Trigger, 2. Peak of Inflated Expectations, 3. Trough of Disillusionment, 4. Slope of Enlightenment, and 5. Plateau of Productivity [10, 11]. As a third dimension, Gartner shows the forecasted time to reach the plateau of productivity in the graph. The forecasted periods are categorized in four groups: less than two years, two to five years, five to ten years, more than ten years [7].

Dedehyir and Steiner already analyzed the quality of the forecasts of Gartner's Hype Cycle for Emerging Technologies. They found that there exist inconsistencies [7]. They developed a scheme for tabular representation of the data. Although they published their findings in 2016, they only considered the Hype Cycles from 2003 to 2009 [7].

3 Research Design

The Gartner Hype Cycle for Emerging Technologies is published yearly since 1995 [7]. In our analysis, we consider the years 2005 to 2019. We transformed the data from

the graphical representation of the Hype Cycles into a table representation like Dedehayir and Steinert. At first, we prepared the data. Technologies with similar trends were merged, e. g., 'SOA' and 'Service Oriented Architecture'. Then we sorted technologies out, which could be found only once in the considered period. In this case, we were not able to compare and analyze the quality of the forecast. Nevertheless, the question, why a technology occurs only once in the Hype Cycle, is not of less interest.

We analyzed the following criteria: *occurrence*, *phase progression* and *forecast*. The criterion *occurrence* describes that a technology occurs constantly for several years in the Hype Cycle. With this criterion, we analyzed the existential accuracy. A technology is classified as 'correct' according to occurrence, if a technology occurs yearly from the first appearance to the last appearance in the Hype Cycle. The criterion *phase progression* describes that a technology goes through the phases in the right or wrong order. Right order means that a technology is in the following year still in the same or in the next phase, because each technology has its own speed. False order means, e. g., if a technology is in the following year in an earlier phase. A technology does not necessarily start in the first phase. It is also possible that a phase is skipped. It has to be analyzed the individual case why this happens. The third criterion is the *forecast*. Here, we analyze, if the forecast of Gartner is plausible. A forecast of a technology is classified as 'false', if the forecasted time to reach the plateau of productivity of a technology is longer or much shorter (2 or more levels) than in the year before. Figure 1 shows the procedure steps of the data analysis.

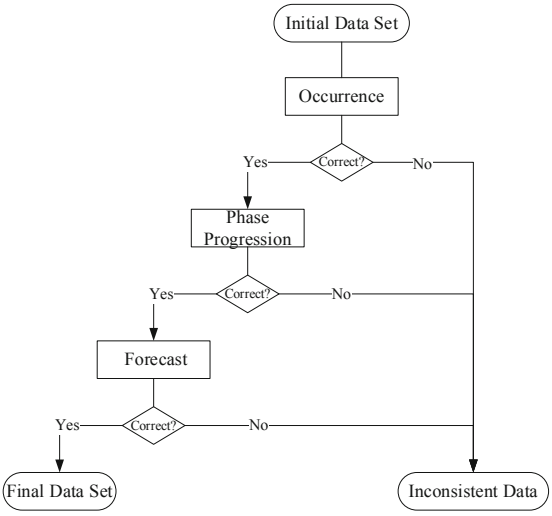

Fig. 1. Procedure of data analysis

4 Analysis

In the initial data set, we have 122 technologies, which exist at least in two Hype Cycles. In the final data set, we have 81 technologies, which occur for several years without

missing in between, which have a correct phase progression and consistent forecasts. This means that the data of 66.4% or round about two third of technologies, which exist at least in two Hype Cycles are consistent. Table 1 shows the details.

Table 1. Results.

	Correct	False
Occurrence	97	25
Phase progression	90	7
Forecast	81	9
Total	81 (66.4%)	41 (33.6%)

4.1 Occurrence

If a technology does not occur continuously in the hype cycle, it is classified as 'false'. An example is the 'Virtual Assistants' technology shown in Fig. 2.

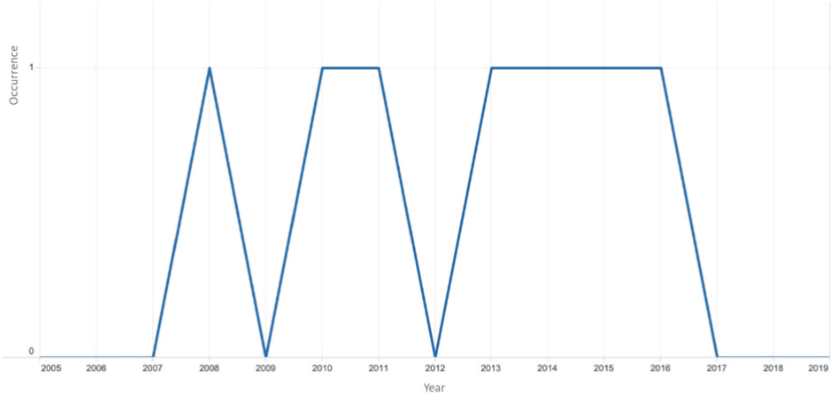

Fig. 2. Occurrence virtual assistants

The chart shows the occurrence of the technology from 2005 to 2019. The y-axis indicates the occurrence. The occurrence can have two states: zero means that the technology is not included in the Hype Cycle of the corresponding year; one means that it is included. The 'Virtual Assistants' technology appears in the Hype Cycle for the first time in 2008, but is not included in the following year again. In 2010 and 2011, the technology was reintroduced into the hype cycle, before disappearing in 2012 again. From 2013 to 2016, 'Virtual Assistants' appear annually in the Hype Cycle. This observation lead to the question, why is this technology not included in the Hype Cycles in 2009 and 2012. Such fluctuations in the occurrence of a technology reduce the comprehensibility and significance of forecasts. This in turn can unsettle companies that base their strategy on such prognoses.

4.2 Phase Progression

The second criteria is used to analyze the phase progression of a technology. If a technology runs against the phase direction, e. g., from phase 2 back to phase 1, the technology is categorized as 'false'. The example of the 'Gesture Control Devices' technology is shown in Fig. 3.

The chart shows the occurrence of the Gesture Control Devices technology in the Hype Cycle in the different phases from 2005 to 2018. The five phases of the hype cycle are shown on the y-axis. The Gesture Control Devices technology appears in 2014 for the first time in the Hype Cycle and Gartner placed it directly in phase four, the Slope of Enlightenment. This raises the question why the technology skips the first three phases of the hype cycle. One possible explanation is that Gartner has identified the technology too late. In 2015, the technology remains in the fourth phase, which is reasonable, since slowly developing technologies can stay in one phase for a longer time. However, Gartner revises its assessment in 2016 by moving back the technology in phase one of the hype cycle. The development process of Gesture Control Devices within the Gartner Hype Cycle does not seem to make sense, since the initial assignment of the technology to phase four was changed to phase one after two years. It is also questionable that the technology subsequently disappeared from the Gartner Hype Cycle. Consequently, the correctness of the classification over the entire time is doubtful.

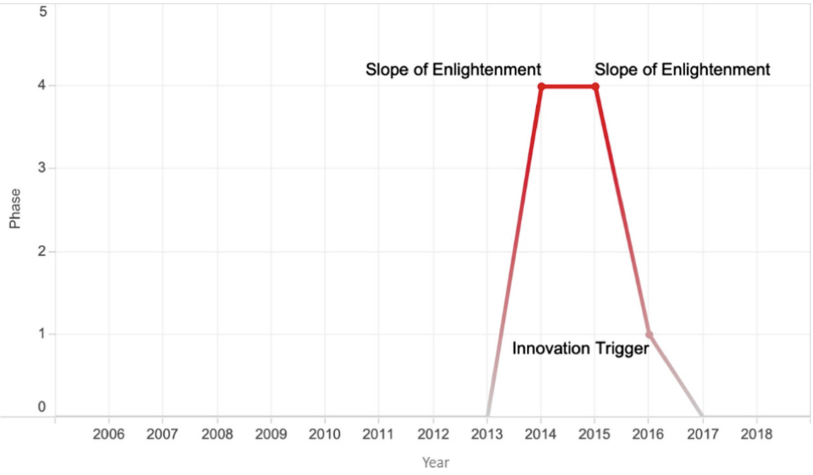

Fig. 3. Phase progression gesture control devices

4.3 Accuracy of Forecasts

The third criteria, accuracy of forecast, is used to analyze whether the forecast pattern of Gartner is consistent. Figure 4 shows the example of an inconsistent forecast for the telepresence technology.

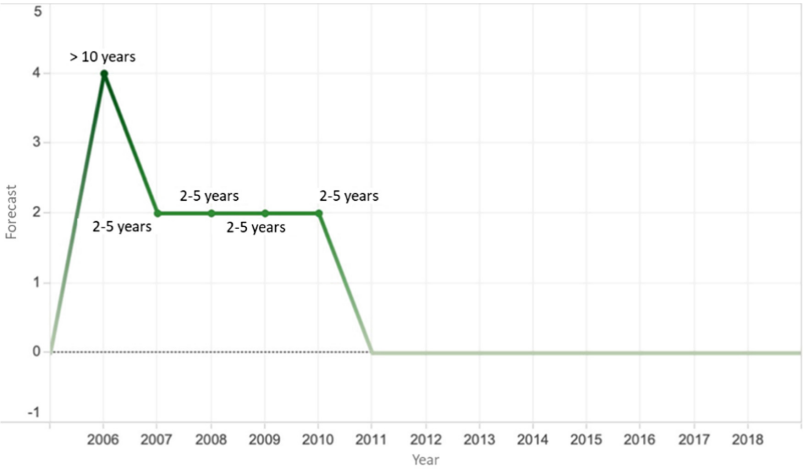

Fig. 4. Forecast telepresence

The telepresence technology appeared for the first time in the Hype Cycle in 2006. For 2006, Gartner predicted that the technology needs more than 10 years to reach the plateau of productivity. In 2007, the technology is included again in the Hype Cycle. However, in 2007 is forecasted that the plateau is reached within two to five years. In the following years, the time to reach the plateau of productivity of this technology was constantly forecasted within two to five years before the technology was removed from the Hype Cycle in 2011. There is a leap from 2006 to 2007. This leap represents an inconsistent forecast because the forecast range from five to ten years was skipped. One reason may be that Gartner underestimated the speed of development of the technology in the first year of occurrence in the Hype Cycle. However, the next question is, why is the technology not considered anymore since 2011?

5 Discussion and Conclusion

Table 1 shows that 33.6% of technologies, which appear two or more times in the Gartner Hype Cycle of Emerging Technologies in the period from 2005 to 2019, have inconsistencies. This means that there is a risk of 33.6% to make wrong strategic decisions for decision makers in industry and research centers, if the latest Hype Cycle is considered. This is the average of fifteen years. Further research can be done by analyzing the appearance of inconsistencies depending on the period. It would be interesting to see how the quality of prognosis changed over time.

Before making decisions, it is beneficial to check if a technology is included in the Hype Cycle for several years. If the prediction is consistent, this means that there is a lower risk to make wrong decisions. However, this works only with technologies, which are considered for a longer time. These technologies are also not very new.

New technologies, which are included for the first time, are also not necessarily very new, e. g., the smartphone technology was considered only once, in year 2006.

There was no similar technology considered, which could be merged and analyzed for a longer period. The smartphone technology was included ten years after Nokia offered Nokia 9000, a portable device that could receive and send emails as well as it had a web browser [12]. Gartner considered this technology in 2006 when there were already sold 64 million smartphones. Brands were Nokia, RIM, Motorola or Palm [13]. All these smartphones had an integrated (hardware) keyboard. The iPhone, which was announced in 2006, was the first smartphone without such a keyboard [14]. The iPhone was also not the first smartphone with a color display [12]. The question is, why Gartner not considers this technology earlier. This technology also does not reach the plateau of productivity.

With our study we can show that not each prediction of a technology in Gartner's Hype Cycle of Emerging Technologies is comprehensible. This is an important finding for decision makers and for all those, who trust private research agencies. All in all, we can conclude that Gartner's Hype Cycle for Emerging Technologies is suitable to provide an overview of current technology trends. Looking at the hype cycles over a longer period of time, we can identify tendencies regarding further developments of trends. However, it is always necessary to consider further studies. It could be extremely risky to rely on only one source.

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Characteristics of Organizational Culture that Supports Corporative Social Responsibility

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Abstract. CSR is much more than a one-way and uncreative view of business, for which profit and profit are the only imperatives that drive it and represent the creation of higher values and the principle and use of incorporation into the value of the organization, through vision and mission. Acceptance and application of corporate responsibilities largely determine organizational culture as a combination of values, beliefs and norms of members of organizations. It is quite logical to assume that the culture of an organization uses its "moral obligation" to do "the right things" and obey socially responsibly.

Modern organizations must focus on developing an organizational culture that respects the values of ethical behavior in all business interactions. Culture in organizations that serve socially responsible encourages customer loyalty, uses interesting investors, becomes an important partner in the market, attracts and retains employees, in other words, acts catalytically on all processes in the organization and on relevant organizations with market and social communities.

This paper discusses the characteristics of Bosis' organizational cultures in which they have achieved high goals, both in quality business and in continuous support for the further development of society. Through its business, investment, employment and innovation, Bosis contributes to economic growth and strives to reduce negative and increase the positive impact on the environment, to be a responsible and desirable employer that respects employee rights and ensures positive work requirements and strengthens relationships with the community.

Keywords: Strategic human resource management · Corporate social responsibility · Organizational culture · Bosis company

1 Introduction

The law of economic rationality, in which there is no place to care for others, is an outdated approach that does not meet the economic or non-economic goals of industrial systems. For an organization that irresponsibly treats its employees, and thus the wider community, the problems multiply many times, because it becomes an unattractive place to work and has problems in gaining talented and promising employees, who have the most valuable of all resources of modern business, knowledge [1].

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 433–440, 2022.
http://doi.org/10.1007/978-3-030-97947-8_57

On the other hand, the behavior of employees in the organization is in the function of adopted norms, value systems and organizational climate and culture, which in the form of organizational measures determine the behavior of individuals. It is of great importance for the organization that its employees are ready to take responsibility for the results of their work, and then for the business results. Many proactive and innovative organizations, through their business, have found that only a combination of corporate responsibility and true commitment of employees, who are personally responsible for the results of their work, to achieve their goals and achieve the goals of the organization, gives outstanding business results in quantitative and qualitative terms [1].

Initially, it was considered that the business of an organization has almost no impact on the society in which it operates. This perception has changed very quickly, especially with the growing social awareness that the organization can influence the creation of higher values and principles in a society, which go beyond the view that making a profit is the sole task of the organization. Connecting people and cultures around the world, through the creation of higher values and principles and their incorporation into the value of the organization, through vision and mission, is far above narrow, one-way, one might even say uncreative, business observation, for which profit is the only imperative which drives it.

CSR generally refers to the organization's decision to behave ethically and contribute to economic development, while showing respect for its employees, the community, society as a whole and the environment. Corporate responsibility is viewed from the standpoint of legal, ethical, economic, environmental, organizational, social and philanthropic perspective. Organizations, which aim to develop and advance, make efforts to meet these aspects of corporate responsibility.

Desirable corporate responsibility is part of the overall patterns of social responsibility and in practical terms means that organizations, within their organizational and management areas, must: Develop sensitivity to issues that affect the lives of the people they live and work with; Understand and recognize the factors of social life on which they could have a positive impact; Consider the social impact of financial and business decisions on a wide range of components of society, especially its employees and Share awareness of the way production and/or service processes take place and their impact on the environment.

Individuals and social communities depend on the organizations that operate within them and through which they earn resources for living, but the business success of organizations also depends on the people employed and the social community in which it operates. The application of the concept of socially responsible business is a real challenge, because it strongly influences the development and improvement of human resources in every organization, whether it is profitable or not. Regardless of the size and type of organization, human resources are what determine its profitability, productivity and competitive advantage.

2 CSR as a Strategic Commitment of the Organization

Corporate responsibility has its strategic and operational dimension and has an increasingly crucial role in the successful promotion and application of a holistic management philosophy and a human resource management philosophy [1].

By reviewing their mission, goals and business strategies and working on strategic changes, many organizations decide to reorient their businesses and move their business activities into the domain of public - private partnership. Corporate social responsibility is becoming an important part of the mission and global business strategy of modern organizations, but also a concept and model for itself. In other words, the corporately responsible business of a modern organization is integrated into the mission of the organization and permeates all activities of that organization. Corporate responsibility only makes sense if it is accepted by all employees and if everyone takes their share of responsibility.

Through its mission, the modern organization changes the way of thinking of employees and the attitude towards the organization, in other words, it affirms organizational values. It is now the mission of a socially responsible organization to consider the full extent of its impact on the community and the environment when making decisions, by balancing the needs of neutral actors with its need to make a profit. This holistic approach views organizations as equal partners in communities, rather than evaluating them solely on the basis of products and profits.

The strategy of corporate social responsibility is developed and implemented in those organizations that have decided to operate in accordance with ethical business principles, taking into account social, environmental and economic impacts. Corporate responsibility refers to actions that bring social good, sometimes contrary to the interests of the organization, but in accordance with the law. Corporate responsibility is presented as a strategy that deals with the impact of the nature of work on society and as a strategy that integrates work and community [2]. The essence of the corporate responsibility strategy is that its application in the organization creates an ethical way of doing business and enables economic development, while at the same time increasing the quality of life of employees and their families, as well as local communities and society as a whole.

The corporate responsibility strategy implies the decision of the organization on whether or not it wants to be involved in social issues and problems and, based on that, to create a corporate social agenda - deciding which social problems to focus on and to what extent. Porter and Kramer (2006) point out that strategy is always a matter of choice. An organization that makes the right choices and builds a focused, proactive, and integrated social initiative with its key strategies can only expect distance from competitors, in the positive sense of the word [3]. These two authors also believe that through strategic corporate responsibility the greatest social impact is achieved and most of the available benefits are collected.

In accordance with modern management, the strategy of corporate responsibility is derived from the global business strategy and human resources management strategy. The global business strategy, but above all, the strategy of human resource management is closely related to the strategy of corporate responsibility, because it is natural that the function that cares about the organization and employees, their goals and development, cares about the ethical aspects of business and influences within and outside the organization. It could even be said that strategic human resource management is a prerequisite for corporate responsible business [1].

Corporate responsibility activities include integrating social activities and characteristics into products and production processes, adopting the progressive application

of strategic human resource management, achieving a higher level of environmental protection through recycling and reducing pollution, as well as improving business. By applying human resource management in the organization, a working environment is created in which all rights are supported, fair and ethical treatment of employees is enabled, that is, realization of their personal goals and development. Involvement in community problems and caring for society is just another form of caring for employees.

3 Organizational Culture of an Organization that Supports CSR

CSR constitutes management activities, which may (and should) bring added value to the companies. The authors writing about CSR believe that "CSR must be encoded into the DNA of an organization". This slogan may be easily extended and read as follows: "CSR should be encoded into the DNA of every organizational culture of the company". When assuming that in large corporations, which count on development and social acceptance, the level of the organizational culture is established, maintained and improved, the implementation of CSR principles and activities in the structure of the corporate culture seems not only justified, but indispensable [4].

When we talk about an organizational culture that supports CSR, we are talking about changing the value system of employees in an organization and we are talking about changing the organizational culture. A change in organizational culture is, in fact, a situation in which new values are built into the existing system of valid assumptions, beliefs and values. By adopting them, we ensure more successful development of the individual and the organization.Most researchers of organizational culture agree that the only real change in organizational culture occurs when the consciousness and behavior of employees change. A change in individual interpretive schemes leads to new, common assumptions, beliefs and values, while changes in an individual's behavior change all external manifestations of that behavior [5].

Organizational culture is nothing but an organizational value system that is equivalent to an individual value system. The individual value system can differ from the organizational one, which opens a very important question of socialization of employees and their acceptance of organizational culture. It is a process in which individual and organizational values are harmonized, and, if necessary, modified [6].

Values appear not only at the individual but also at the organizational level. They represent a basic component of the content of organizational culture. Values in organizational culture represent those individual values that are accepted by most employees, and therefore affect the behavior of the organization as a whole.

If corporate social responsibility is vested in gaining the trust of stakeholders, inside and outside the organization, then the fundamental philosophy must be based on the organization's ability to build relationships. Relationships are established between people and cannot be mandated by strict adherence to systems and processes. The people within the organization must subscribe to the values of the organization and those outside the organization must admire those values. The organization must be values driven. Thus, the organization that espouses corporate social responsibility must develop an environment where people in the organization work together in a harmonious manner and external stakeholders form an emotional connection with the organization while

maintaining its commitment to the financial investors [7]. A successful change in organizational culture implies that employees should participate, that is, want to participate in that change. Gaining their trust is a sensitive and slow process and should enable "their basic human need for achievement, a sense of belonging, a sense of control over one's own life and the ability to live in accordance with one's own ideals" [8]. According to Koter, such leadership is a real emotional skill.

4 Characteristics of the Organizational Culture of the Company Bosis from Valjevo

4.1 Research Methodology

The research part of this paper was created as a result of interviews with the business owner, HRM manager and employees in the human resources sector and insight into the mission and other documents available on the company's website. This empirical research explores the phenomenon of organizational culture and CSR in its real context. It is a specific case study, refers to a very successful domestic company that has existed for almost 40 years and which bases its business on the principles of socially responsible business for which it has received a number of domestic and international awards and provides numerous opportunities for future research.

4.2 About Bosis

The family company Bosis is a leading manufacturer of printed and laminated cardboard packaging and blister cardboard, inspired by the mission to pack all brands in a quality and modern way. Founded in 1982 as a small craft shop for screen printing, it has grown into a regional leader in its industry, which today has 135 employees and more than 176 satisfied customers [www.bosis.com].

4.3 Bosis Strategy

Family Values as the Foundation of Organizational Culture - Bosis is a family company, and it bases its organizational culture on family knowledge. Initially, after the establishment, only family members of the owner and director worked in the company. From the very beginning, the family has been involved in the work and development of the company, so a system of family values has been built and established, which means that all employees are members of the Bosis business family, which today consists of 135 satisfied employees.

In addition to the employees themselves, members of their families are also included in the Bosis business family. The idea is that all employees at work feel like they are in their family circle. They are convinced that only satisfied employees, who receive support every day and have confidence in their employer, achieve high work performance and good results in the workplace. Through the Bosis Family program, for more than two decades organization has been able to achieve one of its most important goals, which is for Bosis employees to come to work every day with a smile, contributing to the overall results and performance of the Company and society. This is a very strong characteristic of Bosis' organizational culture.

Respect and Appreciation of Diversity as an Integral Part of Organizational Culture - Despite the fact that the national mentality has pronounced conservative and patriarchal characteristics, Bosis has managed to develop and nurture an organizational culture based on rapid and effective adaptation to change, inclusion of diversity, tolerance of uncertainty support and participation. Warmth, hospitality and kindness as recognizable features of national identity, have been transferred to the corporate culture and are an integral part of everyday business communication and correspondence, both inside and outside the company.

Care and Responsibility Towards Employees - Sustainability in the Long Run - One of the most important ways to realize the principle of social responsibility is to take care of employees, especially from the aspect of education, health and safety at workplace, planning and career development. Bosis pays special attention to equal treatment of all employees and potential employees, especially from the aspect of respecting the principles of the right to work and avoiding all forms of discrimination.

Bosis provides equal opportunities to all job candidates and employees, and hires, evaluates and rewards them solely on the basis of their competencies, performance and results, and not according to other characteristics such as: gender, birth, language, race, skin color, age, pregnancy, health condition, i.e., disability, nationality, religion, marital status, family obligations, sexual orientation, political and other beliefs, social origin, property status, membership in political organizations, trade unions or some other personal characteristic.

At Bosis, every employee makes a difference. The diversity of employees in all relevant areas has been promoted. The experience, knowledge and creativity of employees are the foundation of Bosis' competitive advantage, in addition to product quality and attitude towards stakeholders. Bosis provides challenges, appreciating and rewarding employees in order to do an excellent and responsible job and create sustainable value. Each employee provides a personal example, takes personal responsibility for their individual development, behaves with integrity and does their job at a high level.

Top Results to High Goals - The goal of doing business at Bosis is to achieve business excellence and reach a top class of products. In this context, an important element of a company's social responsibility is respect for moral rules and fair business practices both in the market and towards employees.

Reputation - Bosis' reputation as a responsible company and a trusted partner is one of the most important means of achieving success. To preserve the reputation of the Company, the work adheres to high ethical standards, respect for its K3P values with constant review: Quality - which justifies our way of doing business, Reliability - You can always believe what we say and promise, Partnership - achieving common goals inside and outside Bosis, and Progress - the commitment to continuous excellence. * taken from www.bosis.rs.

Reporting - Bosis reports regularly and transparently on its financial and non-financial results from year to year. The financial statements have been verified by an audit firm and are publicly available, while the non-financial statements covering the results achieved

in the areas of corporate social responsibility UNGC and GRI are available through all communication channels.

Cooperation and Communication with Stakeholders - Bosis has defined various stakeholders that are essential for the company's success. Close cooperation and communication with stakeholders is considered to be a part of its daily activities. Bosis respects dialogue with all stakeholders, regardless of their views, and strives to connect with them in a constructive way and with long-term impact. Bosis stakeholders are individuals, groups and organizations that are directly or indirectly related to and influence Bosis, as well as those individuals, groups and organizations that are affected by Bosis, and together have a positive impact on environmental, social and other issues.

Bosis Family - The Bosis Family program includes and implements its activities through a defined system of benefits, tangible or intangible support, organizing actions, celebrations and socializing events, and has been operating for more than 20 years. All company procedures are created precisely to support the Family Friendly concept. The motivation package, which consists of financial and non-financial part, is the same for all employees, regardless of the organizational level. As a real family, important dates and holidays (birthdays, New Year, births, Family Day,…) are celebrated together in the business family circle in Bosis. A satisfied and happy team is the basis of any successful business, and every member of the Bosis business family is extremely important and equally respected. Constant care for employees and their families, health and safety, satisfaction and professional development are set in order to develop a strong team spirit and create a balance between business and private life of all employees. Special attention is paid to the health and safety of employees, as well as health promotion and disease prevention through the organization and implementation of free systematic examinations for employees and preventive examinations.

No strategy will be successful if the entire organization is not permeated by the philosophy of human resource management based on holistic principles, which provides synergetic effects and provides employees with fair conditions in which, by advocating for the success of the organization, they can successfully achieve their individual goals. People think of employment more as a social relation, ie a social relationship, than as a contract, and it is important to them that the organization in which they work is caring, reliable and trustworthy [9]. The great example of the Bosis company best illustrates this.Bosis is caring, reliable and trustworthy, both for its employees and their goals, and for organizational goals, but also for the consequences, that is, the effects of its business, which is reflected in the wider community.

5 Conclusion

CSR is integrated into the business itself and is closely linked to adjusting to societal expectations regarding its behavior within the community. The key is to raise awareness of the common destiny of all of us, of the interdependence in which we find ourselves as individuals, as employees in organizations, as members of society and the inhabitants of the planet whose resources we relentlessly spend. The company Bosis, that is, the

owners and employees together, is aware of the importance of its role in society, which is an example of selfless giving and action, which is confirmed by numerous awards and social recognitions. The example of Bosis' strategy is inspiring in many ways and on many levels. Bosis' strategy also includes elements of an organizational culture that supports CSR within and outside the company, primarily to its employees through well-designed human resource management. As a result, employees behave responsibly towards their customers and suppliers and the wider community and the environment, with the development of personal responsibility.

Continuous improvement of the company and striving to go one step further, following global trends in management and technology, emphasis on long-term cooperation and good partnerships, care for employees, but also the environment and the local community are exactly what sets Bosis apart in the European market. The company owes its success to the hard work of its employees and planned sustainable development, which has been insisted on from the very beginning.

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The Role of Chinese Investments in Central and Eastern Europe within BRI

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Abstract. Belt and Road Initiative has ignited hope in many countries that, through cooperation with China, it is possible to achieve the development of these countries However, the realization of the projects was quite slow, which can be explained by Chinese inadequate decisions, as well as the position of the USA and the EU that, for political and economic reasons did not want China to position itself significantly in Central and Eastern Europe.

Keywords: BRI · Chinese investments · Central and Eastern Europe · Innovative technologies · 5G · AI

1 Introduction

The subject of the paper is the role of Chinese investments in Central and Eastern Europe within the BRI and the difficulties in the implementation of these projects. The paper focuses on the problem of responsibility in relation to the difficulties observed in implementing Chinese investments in Central and Eastern Europe. Namely, a significant problem exists regarding the role of China and the answers to the questions on whether it makes inadequate and untimely business decisions due to insufficient knowledge of the specificity of the business environment or, on the other hand, the responsibility lies with the US and EU administrations, which consider China to be a threat to their own interests in Europe. The paper covers the implementation of Chinese investments within the BRI Initiative, 17 + 1, as well as investments in infrastructure, the energy sector, with special emphasis on initiatives and implementations of new innovative technologies in the field of artificial intelligence (AI) and the fifth-generation data transmission standard (5G). The aim of this paper is to point to the most substantial problem of Sino-European cooperation, which lies in the fear of economic and technological supremacy of one of the parties. It is aimed at highlighting, in a more complete way, the points that would be required to produce reduction directed towards harmonization [1], on the basis of the problems diagnosed, i.e. towards systematical resolution of the problems and directing of activities to the creation of solutions for mutual benefit. During the research, an analysis of studies related to economic, political and technological factors as well as a strategic opinion on the areas covered by the paper was performed, from which the classification of problem areas and generalization of their key causes was derived.

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 441–447, 2022.
http://doi.org/10.1007/978-3-030-97947-8_58

2 Belt and Road Initiative

By all means, Belt and Road Initiative (一带 一路) is the largest economic and geopolitical project in the history of the People's Republic of China, whose ultimate goal is to completely reshape the Chinese state and restore the status of a developed power that will have dictated innovations to the world by 2049 [2]. There were numerous doubts about China's ability and capacity to bear such a large project, because the developed countries of the West were tucked into their untouchable position. The countries of Eastern, Central and South-Eastern Europe that were in dire need of investment in infrastructure and development programs have been identified as desirable partners in Europe as the final destination of the Initiative. A special platform for cooperation between 16 countries of Central and Eastern Europe with China - Cooperation between China and Central and Eastern European Countries (China-CEE, China-CEEC), better known as the 16 + 1 Initiative, was soon formed. After the accession of Greece, this Initiative was expanded and is now called the 17 + 1 Initiative [4].

3 17 + 1 and Chinese Investment

Initially, the member states of the 17 + 1 mechanism had high expectations from the Chinese investments. Wen Jiaobao (温家宝), the Chinese Prime Minister at that time, promised a $10billion credit line for Chinese investment in Central and Eastern Europe [5]. Plans to build new transport corridors that would connect Europe, build bridges and other infrastructure facilities, reconstruct ports and transport hubs, as well as projects that significantly increase the region's energy potential have been springing up.

3.1 Chinese Investment in Infrastructure

One of the priorities was the creation of a logistics corridor between the port of Piraeus, whose ownership structure has meanwhile been entered by the Chinese, through the Balkan countries to the European markets where Chinese goods are to be placed [6]. For the first time in 2013, it was agreed that Serbia and Hungary, in cooperation with the Chinese, would build one such high-speed railway using Chinese technology on the Belgrade-Budapest section, which would also become the first section of the future railway corridor connecting the south and the center of the European continent [5]. Although the projected completion of the works was planned for 2017, the works on the Hungarian side of the border did not go far, due to bureaucratic problems with the Brussels administration, which accused the Hungarians of non-transparency and non-compliance with prescribed procedures that every EU member state must follow [5]. During that time, the Chinese company China Road and Bridge Corporation (CRBC) built, back in 2014, the Pupin Bridge that connects Zemun and Borča, being the first bridge erected by Chinese builders in Europe [7]. In Serbia, Chinese companies also participated in the construction of the highway "Milos the Great" (E763). The a/m Chinese company CRBC is building the first highway in Montenegro, Bar-Boljare, which is the largest construction and investment project since the country gained its independence, while the entire project is financed by the Chinese Exim Bank. Such Sino-Montenegrin cooperation is not viewed favourably in Western capitals [5].

3.2 Chinese Investment in Energy Generating

An example of successful cooperation attributed to the 17 + 1 mechanism is the reconstruction of the Kostolac thermo-electric power plant in Serbia [8]. Thus, the energy capacity of Serbia has been significantly increased. Unfortunately, the Romanian-Chinese project of Cernavoda nuclear ower-plant, whose completion is lagging behind due to the Romanian political situation and the EU's dissatisfaction as well as other project like the Rovinari thermo-electric power plant and the Tanita-Lapustesti hydroelectric power plant are also nowhere near completion [5].

3.3 Chinese Investment in Industrial Plants

The best example of Chinese investment in industrial plants is the example of privatization in Serbia – the takeover of Smederevo steel mill by the giant Hesteel in June 2016. Thanks to tariff free steel export agreements to the EU market, which helped overcome the existing administrative barriers, this said steel mill recovered quickly due to much needed investment and the application of Chinese technology and good management [5]. After the bureaucrats from Brussels realized this, they abolished the preferential status for the export of steel from Serbia.

4 The Role of Chinese Investment and the "China Threat Theory"

The prevailing opinion is that by investing in Central and Eastern Europe, China seeks to gain political power and build its structural might and a mode to influence processes in those countries. In March 2017, EU foreign policy chief Federica Mogherini warned that "The Balkans can easily become one of the chessboards where the big power game can be played." These were the first signs that Europe was assessing China's political and not just economic influence [2]." The Western Balkans could one day become the Chinese "Trojan horse" in the EU said, in Julz 2018, Johannes Hahn, the then top official in charge of the neighborhood policy and enlargement negotiations [10]. More and more radical theses are being increasingly heard among within the ranks of the European academic community. China is dividing and conquering Europe. China is rebuilding the Eastern bloc. China is buying the fragile post-socialist democracies of Europe "on the cheap". All these theses by which pro-Western thinkers try to describe BRI & 17 + 1 are a reflection of the structural and discursive changes that are currently taking place in Sino-European relations [11].

4.1 China Threat Theory

The term "China Threat Theory" refers to a set of fatalistic narratives and contemplations according to which China cannot now, or in the future, develop through a peaceful relationship with other countries, but its ultimate goal is to overthrow the existing world order that depicts balance and stability [12]. Therefore, the duty of the West is to oppose China to avoid a catastrophe of planetary. That is why the Europeans mostly talk about Chinese infiltration and subversive activities that result in "Chinese influence" in Europe, and that all such actions have a hidden political basis. The Belt and Road Initiative as

well as the 17 + 1 mechanism, which are conceived as platforms for cooperation and economic development of the participating countries, have met with great suspicion from Brussels, which considers itself to have an exclusive deed to all countries of the European continent and that it is not at all ready and in the mood to see real competitors in its backyard, who, after making investments, could think about throwing a glove into the face in terms of political power and supremacy in this part of the planet. That is why the existing Chinese projects and investments should be blocked bureaucratically in all ways (as seen on the example of the Belgrade-Budapest railway line), and all future investment projects should be passed through the investment screening filter. They even managed to push out the "Sofia Guidelines" agenda setting document during the meeting of 16 + 1 leaders in Sofia in 2018, which was to commit all participants to promote "practical cooperation though pilot projects within the framework of the EU-China Connectivity Platform, the Investment Plan for Europe and the extended Trans-European Network (TEN_-T)". In this way, they made it clear to all countries that want to cooperate with China and be open to its investments, especially in the Balkans - that this cooperation can take place according to the principle of the EU's way or (Chinese) highway [13]!

5 Chinese Innovative Technologies and Reactions on Their Implementation

The rapid development that China has achieved through economic development, and even more through the comprehensive revolutionary development of the technical and technological capacities at its disposal, has aroused the suspicion of the West. If at the beginning of the decade the BRI was viewed with great suspicion and skepticism, now all of China's moves are viewed with apprehension. What is especially problematic is the fact that China has managed to develop a number of its high-tech companies, which have grown from the position of so-called copycat companies into real technical-technological innovators who create and impose new trends on the world. On the international scene, the example of Huawei, which has been present on the European market for two decades, and which has grown from a manufacturer of cheap supplements for telecommunications companies to a true leader and creator of new trends and standards in telecommunications, should be especially noted. In just a single decade, Chinese investment in Central and Eastern Europe, as well as the use of Chinese equipment itself, has become a first-class political and security issue the West wrestles with. What is very topical now is the question of whether Chinese companies and managers, through their unique business and management system, and with the help of innovative technologies developed in China, can be in a significantly more competitive position compared to their European competitors, and thus affect the realization of short-term and long-term Chinese goals within the BRI?

5.1 Digital Silk Road and Made in China 2025

The Digital Silk Road (DSR) was introduced in 2015 as part of the Chinese government white paper, as one of the segments of the BRI. The DSR is actually a concept of an "umbrella" by which Beijing seeks to unite all its high-tech companies (Huawei, ZTE, Alibaba, Tencent, Baidu,…) and promote its global vision through the use of

technology in various fields of application [15]. The Chinese are aware that, through the project of digitalization and development of innovative technologies, they will enable their companies to play an increasingly decisive role in the world market, as well as to dictate and impose international patents and standards, which would significantly increase the profitability and effectiveness of their companies abroad. In addition to the evident need for digital infrastructure, EU member states are increasingly raising security issues regarding privacy and data protection. Made in China 2025 In the same year that The Digital Silk Road (DSR) was introduced, the State Council presented a ten-year plan "Made in China 2025" (中国 制造 2025) [19]. This ambitious plan aims to transform China from a global factory that depends primarily on the intensive work of its cheap labour force, to a developed digital technology society that relies in its production on innovative technologies, artificial intelligence, broadband high-speed Internet (5G).), all of which are the foundations of a society that has gone through the fourth industrial revolution and has 4.0 Industry as its base. Special attention is paid to the fifth generation (5G) mobile network, which is the basis of a comprehensively digitized society, and artificial intelligence (AI), collecting, processing, filtering data and making decisions based on them [20].

5.2 5G

The new fifth-generation data transmission standard, which is 20 to 100 times higher than all the existing mobile Internet networks, has attracted unprecedented attention from the entire public, who discusses the positive and negative aspects of the introduction and application of this new technology [21]. Unlike previous generations of Internet networks, data transfer speed is not important for the end user-individual, but for the entire system of a society - industry, state and local government, security, research and development, medicine … By achieving high data transfer, the society creates predispositions for the digitalization of all aspects of life, and with the help of artificial intelligence new systems are made possible, such as the concept of smart city, self-driven vehicles, various forms of online to offline businesses [16]. For the first time in history, the absolute leader in the development of new technology is a Chinese company - Huawei, which has complete technological solutions for the design, construction, operation and use of 5G technology [22]. Although Chinese plans were very ambitious in building 5G across Central, Eastern and Southeastern Europe, a scandal erupted in the Czech Republic in the late 2018 when the country's intelligence service issued a warning against the use of equipment made by the Chinese companies Huawei and ZTE. Shortly afterwards, an affair broke out in Poland in January of the following year, when Polish security agencies arrested a Huawei employee and a local, a former security official, on charges of spying for China. These events were the prelude to a comprehensive anti-Huawei campaign, which put the company under the scrutiny of suspicion that it could extract information about its users and supply it to Chinese security agencies through hidden protocols. The issue of safety is thus placed before the economic and technological ones and all European countries are recommended not to use Chinese equipment, but to look for an alternative with the European companies Ericsson or Nokia. By blacklisting Chinese technology companies, allegedly for security reasons, Chinese investing in digital infrastructure in the countries of Central and Eastern Europe participating in 17 + 1 and the DSR, have been disabled.

5.3 AI

The information and data that can be used in digital technologies is the oil of the 21st century, and the country that has the most data on the basis of which it will achieve deep learning of artificial intelligence will be the dominant force of the century in which we live. In 2017, China adopted the "New Generation Artificial Intelligence Development Plan", which set it to become the absolute world leader in artificial intelligence by 2030, bringing its economy an annual income of trillion yuan ($150 billion). Through the guidelines of this plan, China seeks to gain leadership as soon as possible, and use AI to achieve leapfrog development and compensate for the backwardness of its country and economy that failed to take part in previous industrial revolutions throughout history. Chinese companies have advanced in the application of AI that they are considered to be the leaders in smart city systems, cloud of self-driven vehicle and transport management systems, as well as medical diagnostics.

6 Conclusion

Although ambitiously conceived and with substantial potential, investment projects within BRI and 17 + 1, have faced numerous difficulties during implementation. Recognizing that the responsibility for numerous omissions lies with the Chinese side which, due to lack the of understanding of specific business issues in Eastern and Central European countries, did not always take adequate steps, the biggest obstacle to more serious and fruitful cooperation between 17 + 1 and China is the political position of the US and the Brussels administration. Considering the countries of Central and Eastern Europe as their backyard in which they have absolute and sovereign rights to decide on everything, China and its investments are perceived as an alien and disruptive factor that has to be cropped and eliminated. The specific structure of China's management system using modern technologies and strategic orientation towards the development of innovative technologies and digital society is also seen as dangerous because, with further growth and development, China could become technologically superior making its companies more efficient, effective and thus much more profitable in relation to western competitors, which is a situation that the West cannot allow. The current Covid 19 epidemic, as well as the enactment of EU regulations and bans to EU member states on using Chinese advanced technology in new telecommunications and digital projects, only accelerated the momentum of some inevitable events, which showed the rules of the market and political game on the European stage.

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The Influence of the Project Mature Organization Factors on the Agile Transformation

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Abstract. In the conditions of a dynamic environment and constant market pressures for the implementation of internal and external changes, organizations have a great challenge, how to remain flexible, and at the same time stable and competitive. One of the approaches that enables the harmonization of these contradictions is the concept of creating an agile organization, whose basic values are competence, cooperation with clients, continuous communication, transparency and flexibility. As a relatively new way of thinking, organizational agility enables efficient and effective placement of goods and services, as well as a quick response to competition activities. In this paper, using the Delphi method, the analysis of the influence of factors of project-mature organization, defined on the basis of theoretical assumptions, on agile transformation was performed.

Keywords: Agile organization · Agile transformation · Delphi method

1 Introduction

Complex endeavors that require the engagement of a large number of experts of various profiles and significant material resources, as well as short deadlines for implementation, require a special organizational structure, the so-called. project model of organizational structure.

A project organization is one that is project-oriented, i.e. emphasizes belonging to the project, not the department, and subordination to the project manager rather than the functional manager. The staff is organized within, i.e. around the project, and team members usually belong to the same organizational unit.

However, today, when the habits and needs of customers and users are changing rapidly, the flexibility of the organization and its willingness to respond to the challenges facing it are a prerequisite and imperative for success in the market.

Taking into account the above, compared to the traditional approach, the agile approach is most suitable for complex systems and situations where changes are frequent and unpredictable, when accurate estimates and stable plans are almost impossible, and when early predictions and solution design are at the beginning.

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 448–456, 2022.
http://doi.org/10.1007/978-3-030-97947-8_59

Agile methods of large projects in large organizations is the title of the work of authors Brian Hobbes and Ivan Petit. The paper investigates the adoption and adaptation of agile methods for use on large projects, in large organizations. The authors emphasize that the use of agile methods requires significant adjustments, both at the project level and at the organizational level [1].

Jan Riker et al. tried to answer the question of how agile practices affect customer responsiveness and development success, where it is stated that methods of developing agile information systems have become popular, but what specific agile practice to use remains unclear. Also, the paper shows that different practices affect agile teams, ie customer responses in different ways, and finally, that they contribute to the successful development of software in different ways [2].

In their research, Torgir Dingsoyr et al. point out that software development projects have undergone significant changes with the advent of agile development approaches. Although mainly intended for small, self-governing teams, these approaches are also used today in large development programs. The main challenge is the coordination of many teams. The results of the research indicate the importance of coordination, based on feedback, the use of numerous mechanisms, and how coordination practices change over time [3].

2 Agile Organizations

Organizational agility can be presented as the ability to quickly reshape strategy, structure, processes, people, and technologies, with the goal of creating new value. It is based on continuous improvement, through continuous learning and becomes a necessity and need of every organization that wants to stay and become competitive and sustainable, in today's changing market.

The agile framework focuses on delivery when demand is volatile and when changes in requirements are very frequent. The goal of the agile approach in production is to unite organizations, people and technology into one integrated and coordinated whole, which will be agile [4].

The implementation of agile practices in business processes is a very complex process, due to the great resistance of employees to change, the need to involve top management in the process and the specifics of the organizational culture of the organization. The group of authors identified the following inconsistencies between the pilot projects and the overall organization of the company [4]:

- relationship with clients,
- job requirements management,
- implementation of product architecture,
- legal system,
- relationship with other project teams,
- quality management systems,
- change management committees in organizational and software processes.

The idea of agility can be broken down into three main characteristics [5]:

1. adaptability, i.e. to respond in an adequate way to unpredictable and frequent changes,
2. slenderness, to reduce the amount of artifacts produced and
3. speed, which indicates the time criticality and importance of process efficiency.

Agile methods have proven to be useful and effective in practice and when carefully personalized and tailored to the needs of the company. Agile principles, values and practices are very well known in the software industry, but the problem arises when implementing them in practice. The process of agile transformation largely depends on the culture of the organization and the project environment within the organization. Large companies usually have clearly defined business processes and well-established business rules and general corporate culture, and are therefore not flexible for change and for agile transformation [4].

The agility of an entity is defined through the following five characteristics [4]:

1. Reactivity - the ability to identify external and internal opportunities, and form an appropriate response based on the current situation.
2. Flexibility - the ability to accept predicted and unforeseen changes.
3. Speed - the ability to react quickly to predicted and unforeseen changes.
4. Optimization - the ability to react quickly and flexibly with the optimal amount of resources, without compromising quality.
5. Learning - the ability to constantly learn and apply the latest knowledge.

3 The Factors of the Agile Transformation

The factors of project-mature organization, defined on the basis of theoretical assumptions, are shown in Table 1. The aim of further research was to determine whether they affect agile transformation and to what extent.

Table 1. Factors of project mature organization and their influence on the agility of the organization.

Order number of factors	Factors
1	Collaboration of team members
2	Innovation
3	Speed
4	Responsibility
5	Autonomy
6	Available information
7	Decentralization of the decision-making process

(*continued*)

Table 1. (*continued*)

Order number of factors	Factors
8	Employee flexibility
9	Employee skills and abilities
10	Flexible process model
11	Teamwork
12	Employee motivation
13	Continuous monitoring
14	Impact assessment
15	Resource optimization
16	The team's ability to identify and estimate losses
17	External cooperation
18	Dynamic skills management
19	Improving employee skills
20	Enriching employee tasks
21	Constant, continuous development of employees
22	Proactivly solving customer problems, in terms of creating customer satisfaction
23	Quality of internal communication
24	Quality of external communication

Teamwork involves the search for new ways of working, new ideas and different perspectives, in order to achieve clear goals and gain better solutions.

Innovation, as a property of the organization, consists in the openness of the organization to change, successful change management and successful acceptance of change [6].

Today, rapid change is a specific sign of the times in which we live, where it is considered that an organization cannot operate and develop efficiently, if it does not keep pace with the changes and if it does not use them.

Joint decisions and taking responsibility for a good result are important for teamwork.

When asked what autonomy is, different authors give different definitions, so it can be said that autonomy is the power to shape a workspace in a direction that will allow the employee to do the best he or she can.

Availability and timeliness of information is very important for the successful functioning of the organization, and for achieving its ultimate goal.

Decentralization of decision-making helps top management to delegate tasks to lower-level executives, to make them part of the business process and the necessary solution, engaging them and motivating them to succeed as part of the project [7].

Quality working conditions increase the degree of employee satisfaction with work, which increases the flexibility of employees in performing work tasks, increases their loyalty and motivation, and thus reduces fluctuation and absenteeism.

Competence is a complex combination of knowledge, skills, abilities and attitudes, which are necessary to perform a certain activity in a given context, in real circumstances.

Process flexibility is a concept used in process management, and refers to how an operation responds to external factors, which usually change to supply or demand [8].

The most common definition of a team is that a team is a group of people who work together and together to achieve a common goal [9].

Employee motivation should certainly be one of the primary goals of the management of any organization, because if we have motivated employees, it is quite certain that other goals of the company will be easier to achieve [10].

Monitoring and managing the work performance of employees consists of a series of tasks that are the responsibility of human resource management and is a continuous process of evaluating and directing the behavior and results of work in the work situation [11].

Performance appraisal is the process of assessing how effectively employees are fulfilling their job responsibilities and contributing to the achievement of organizational goals [12].

Resource optimization is a set of processes and methods for harmonizing available resources (human, mechanical, financial) with the needs of the organization, in order to achieve the established goals.

One of the key required skills that a team needs to possess is the ability to identify and then eliminate losses.

External or external stakeholders are partners with whom the company enters into various business contacts (customers, suppliers, banks, etc.), then government agencies, business associations and other entities that express in a more or less direct way the interests of the community [13].

Dynamic skills management is a new option in search of development and application needs.

Developing employee skills also helps in hiring and retaining the best employees, and allows for delegation, leaving managers more time to focus on their other roles.

Enriching the tasks of employees means giving greater authority to the employee, in terms of deciding on methods and methods of work, increasing employee responsibility, increasing cooperation with colleagues, understanding the role that employees have in creating added value as a whole and the like [10].

Employee development is a continuous process that includes formal education, assessment of development potential, work experience and interpersonal relationships [14].

The starting point of all strategies to improve activities to create customer or consumer satisfaction is market research, where future supply trends must be predicted, so that the organization is ahead of consumer and competition requirements, as quickly and efficiently as possible.

Internal communication is related to business communication and means communication that takes place between people within the company [15].

In contrast to internal communication, it is external, which is communication between companies and external stakeholders [15].

4 Experimental Research

The subject of this research, for the purpose of which the Delphi method was used, is to analyze the agile transformation and the factors that influence them. The aim was to determine whether, in the opinion of the panel of experts in the field of IT sector, who participated in the research, the factors of project-mature organization, defined on the basis of theoretical assumptions, affect agile transformation and to what extent.

The pool of experts consists of 10 respondents, where the predominantly highly educated male population, younger in age, predominates.

Based on the assessments of experts, the factors from Table 1, as significant, were taken those who had an average grade greater than 6, and are the same and are given in Table 2.

Table 2. Significant factors of agile transformation.

Order number of factors	Factors	Average rating
1	Collaboration of team members	9
2	Innovation	8.2
3	Speed	7.6
4	Responsibility	7.8
5	Autonomy	6.5
6	Available information	6.6
7	Decentralization of the decision-making process	7.6
8	Employee flexibility	8.2
9	Employee skills and abilities	7
10	Flexible process model	9.4
11	Teamwork	8.6
12	Employee motivation	7.6
13	Continuous monitoring	6.2
14	Impact assessment	8.75
15	Resource optimization	9
16	The team's ability to identify and estimate losses	9.4
17	External cooperation	7.75
18	Dynamic skills management	8.8
19	Improving employee skills	7.8

(*continued*)

Table 2. (*continued*)

Order number of factors	Factors	Average rating
20	Enriching employee tasks	9
21	Constant, continuous development of employees	7.6
22	Proactivly solving customer problems, in terms of creating customer satisfaction	7.2
23	Quality of internal communication	9
24	Quality of external communication	9

After this activity, the director, who is also the owner of QCERRIS d.o.o., based in Belgrade (Serbia), whose company was founded in 2018, was interviewed and asked to give his grades related to agility factors (Table 2).

For the sake of simplicity of review and comparison, comparative average scores, by the pool of respondents (Table 2) and by the respondent are shown in Table 3.

Table 3. Factor ratings, obtained by the Delphi method and by the respondent.

Order number of factors	Factors	Average rating	Assessment of the respondent
1	Collaboration of team members	9	9
2	Innovation	8.2	8
3	Speed	7.6	7
4	Responsibility	7.8	8
5	Autonomy	6.5	8
6	Available information	6.6	8
7	Decentralization of the decision-making process	7.6	8
8	Employee flexibility	8.2	8
9	Employee skills and abilities	7	8
10	Flexible process model	9.4	8
11	Teamwork	8.6	7
12	Employee motivation	7.6	8
13	Continuous monitoring	6.2	7

(*continued*)

Table 3. (*continued*)

Order number of factors	Factors	Average rating	Assessment of the respondent
14	Impact assessment	8.75	7
15	Resource optimization	9	8
16	The team's ability to identify and estimate losses	9.4	7
17	External cooperation	7.75	7
18	Dynamic skills management	8.8	7
19	Improving employee skills	7.8	7
20	Enriching employee tasks	9	7
21	Constant, continuous development of employees	7.6	7
22	Proactivly solving customer problems, in terms of creating customer satisfaction	7.2	8
23	Quality of internal communication	9	8
24	Quality of external communication	9	9

As can be noticed, analyzing the previous table, the estimates related to the agile transformation factors, obtained by the respondents, do not differ much from the average ratings, obtained by the Delphi method.

5 Conclusion

Organizational agility is the term most widely used in industrial and software engineering and is defined as a measure of the flexibility of an organization or system, relative to input sizes, such as customer requirements or day-to-day changes in the business environment. Every organization can benefit from adopting an agile approach, depending on what problems it wants to solve and what it focuses on.

When organizations implement the concept of business agility in their business, a good base is created for the development and encouragement of teamwork, and provides continuous improvement of business processes in the organization, which directly positively affects the achievement of business goals of the organization.

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Individual and Organizational Knowledge as the Main Levers of Business in the Knowledge Economy

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Abstract. Knowledge has become a key resource in modern business, and we come to it in the learning process. The traditional concept views learning as, to put it simply, the acquisition of existing knowledge and skills. The challenge of the knowledge economy is for employees to learn to continuously create new knowledge and skills, that is, to do different things in different ways, and not the same things in different ways.

The problem with knowledge is that it is difficult to quantify and control, and therefore difficult to manage. Part of the knowledge of an organization is possessed by its employees, and the other part is possessed by the organization. It is indisputable that employees participate in organizational knowledge through what they know and do, but the organization also participates in a certain way in shaping the knowledge and abilities of its employees.

The paper discusses the strategic relevance and characteristics of individual and organizational learning and knowledge, their interdependence and the challenges faced by organizations in the process of transforming the knowledge of employees into organizational knowledge.

Keywords: Human resources management · Knowledge economy · Learning and knowledge · Knowledge management

1 Introduction

Organizations can no longer expect the products and practice they successfully employed in the past to ensure their competitive and sustainable advantage in the future. Development of science and technology has led to changes affecting the society and social relations, i.e. we are increasingly becoming aware that we live in a knowledge society, economy is becoming a knowledge economy, organizations are becoming learning organizations, whereas individuals learn throughout their life. Organizations will increasingly differ in what they know or how they employ individuals willing to continuously innovate and upgrade their knowledge. In a knowledge society, modern organizations base their competitive advantage on the knowledge and innovations of their employees and on taking opportunities resulting from that knowledge.

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 457–464, 2022.
http://doi.org/10.1007/978-3-030-97947-8_60

Knowledge is the main strategic resource for achieving competitive advantage and sustainable development [1–5]. Knowledge has become the most important resource in the process of doing business. Knowledge is available to all and it represents the main value ensuring a successful development leading to a common wellbeing and more democratic and human living conditions. It differs from old-time, traditional business resources, as knowledge is the only resource that multiplies by sharing, it is not wasted through use and its value is reflected in its transfer and innovating.

Knowledge is acquired in the learning and education process, it grows through sharing, thus becoming a priority of a contemporary society, the aim of which is survival and progress. Knowledge management is an emerging discipline with ideas that should be tested, and questions at which the right answers should be given [1].

2 Characteristics of Learning

The challenge of the knowledge economy is that employees learn to continuously acquire new knowledge and skills, that is, to do different things in different ways, not the same things in different ways. It is necessary to innovate knowledge, enrich it and to intertwine the old and new knowledge. It is already said that a capability of individuals and organizations to create and adopt new knowledge has become a key comparative advantage. Those present on the information and knowledge market prevail. The others struggle or fail.

Therefore, unlike in the previous stages of development of business organizations, the future of present-day organizations depends almost exclusively on the capabilities of individuals, teams, departments, plants or entire companies to learn and thus continuously develop and increase their creativity, innovation and knowledge.

What is certainly essential is that knowledge does not only imply what is already discovered or known. The aim of the learning process is not only to learn what is already known, but to continuously research what is new and unknown.

Learning should provide knowledge that would enable employees to find a discrepancy between the expected and the accomplished and then to adjust their behaviour accordingly. The result of the adjustment process is manifested as experience that could be applied to other situations and it is a basis of new cognitive processes. In that context, when it is about individuals, as well as organizations, two types of learning are differentiated between. These are learning to survive and learning to create [6].

Learning to survive is the ability of an organization or person to adjust to the market or environment, to compare one's behaviour and correct what is inadequate in it. By learning on one's own and others' mistakes and by following relevant sources of market, scientific, financial and other information, the individual or organization makes preconditions for survival in an increasingly complex market competition. Yet, such approach is sufficient only for a mere "survival".

As a more advanced form of learning, the so-called generic learning is more interesting and current, and its aim is creation and development. Learning aimed at creating is an ability of an individual or organization to change the environment, identify new opportunities and become a source of creative ideas, to develop by recognizing and anticipating or even creating development trends.

Just as changes take place at an individual, group and organizational level, it is important to realize that the process of learning is also taking place at an individual, group and system level. Human resource management (HRM), as a business function, may facilitate and encourage learning at each of these levels.

At an individual level, human resource management is responsible for the selection and retaining of knowledge employees with requisite capabilities (competencies), i.e. performances both in technical terms and in terms of behaviour and values desirable for the organization. HRM takes care of their motivation through performance and reward management. The defined desirable performances and rewards that support them should enable the conversion (reshaping) of their expert cognitive models into explicit organizational knowledge.

Group (team) level requires setting up different teams and groups. At the group level, HRM should train persons to work in independent (autonomous) teams and to exchange their cognitive models in internal and external environment, i.e. outside organizational boundaries.

At the organizational level, all employees relying on the organizational vision, mission and strategies should work together in establishing a creative atmosphere the result of which is learning and knowledge. Organizational learning provides a time cycle optimization framework. The key areas within the framework are behaviour, culture, reward-related learning, and emphasis on the request to do one's work more reliably, faster and efficiently. Likewise, faster and more flexible decision-making and greater delegation of duties could be included in this learning framework.

Such approach to learning increases flexibility and gives employees an opportunity for new challenges. The literature describes different levels, i.e. circles (loops) of organizational learning and they are interconnected as follows [7]:

Level 1: Individual Circular Learning (Single-Loop): Learning how we could do things better and thus improve what we are doing. It is viewed as learning at the operating level or the level of rules.

Level 2: Double Circular Learning (Double-Loop): It is a fundamental level implying asking rather "why" when it is about what we do, than doing same things better, i.e. asking whether we actually should *do other things*. It is presented as development of knowledge and understanding resulting from a clear perception with a possibility of requiring changes or renewal.

Level 3: Triple Circular Learning (Triple-Loop): This level of learning is the most difficult to attain as it focuses on organizational objectives or principles in terms of their adequacy. It is sometimes described as learning at the level of willingness or existence.

By maintaining the climate of learning and creating conditions for employees to renew their knowledge, the organization becomes a learning organization. There are numerous dilemmas if organizations could learn the way individuals do and different authors have the opposing views. Processes and nature of how individuals learn have been examined, yet there is a question how to interrelate that capability of employees with organizational capabilities?

In some papers on organizational learning, individual and group, i.e. collective learning processes within organization are viewed separately. A holistic or comprehensive approach is frequent, as it is believed that organizational learning is better than a set of individual learning within an organization.

Although some pragmatic definitions of learning organizations are increasingly focusing on individual learning, a better support to learning and independent development – organizational learning nevertheless implies much more than a set of individual learning in organization. Only if learning of an individual has an impact on other persons or is related to others – members of organization may learn together and gradually start to change the way they do things. That way a change in relationship among employees is made and a collective, not only individual competency, is increased [7]. The question of how individual learning fits into organizational learning and transformation and why organizational learning is more important than a set of individual learning – is only the beginning of something that should be paid attention to.

3 Characteristics of Knowledge

Knowledge needs to be updated and, if necessary, erased, i.e. forgotten, at an increasing pace. A new law on present day enterprise operations may be defined: the more information contained in a product, the cheaper the product. In traditional industrial conditions the price is reduced with greater quantities of a product on the market, whereas at present, the price falls as greater quantities of information are embedded in a product. This trend is increasingly present in all areas of the economy, and a good example is the price and performances of computers. With this new method of doing business, money is generated from knowledge and information [8].

A feature of knowledge to be a resource and its multiplying through use resulted in the greatest quantities of knowledge ever. A single edition of any daily newspaper, let alone on the internet, contains more information than an individual heard in her/his lifetime in the Medieval Age. There has been a knowledge boom in the past two decades. The United States Patent and Trademark Office grants 195% more patents than only two decades ago. Since the beginning of the 1960s, the number of students conferred an MBA degree in one year, only in the USA increased by1500% [9].

Valuable knowledge is not any more concentrated among only a few highest-ranking persons in an organization. Intellectual labourers (the knowledge workers, as P. Drucker termed them) could at present be found at all corporate levels. Three principal characteristics of knowledge are as follows [10]: It is boundary-free(knowledge travels even easier than money; Vertical mobility (it is available to everyone through easily obtained formal education and a potential of failure, as well as of success.

Criteria for evaluation of resources and of their ability to provide a sustained competitive advantage, as developed by Barney are as follows [8]: Ability to create value for client; Rareness (not possessed by other competing firms), Imitability and Substitutability. Of all resources, only knowledge meets all 4 criteria no matter whether it is termed intangible assets, key competency, strategic asset, key capability, non-material resources, organizational memory, or any other concept of lesser importance.

Our intuition tells us that knowledge is a notion broader than data and information and that it entails both. Those are information that have value in interaction with human

capital, i.e. employees who succeed in creating value. Knowledge relates to the ability of people to use information in solving complex issues and to adjust to changes. That is an individual capability to overcome the unknown. A capacity to act, as knowledge is termed by Karl-Erik Sveiby, one of the prominent professors dealing with intellectual capital. Just as information is a value-added datum, knowledge is value-added information used to perform various intellectual operations (e.g. contextual knowledge, assuming consequences, connecting, claim making). A specific property of knowledge is that it is closer to action than a datum or information. Knowledge is a trigger inducing us to act [11].

A logical consequence of an attempt to better understand the nature of knowledge is its categorization. There are numerous terms, such as, embodiment of knowledge, codified knowledge, multiplied knowledge, procedural knowledge, yet the most frequently used (almost fundamental) is its division into explicit and implicit (tacit) knowledge made by Professor Polanyi [12].

Explicit (known, expressed) knowledge is the knowledge that can be repeated, described or which could be given a formal form which enables its communicability or general understanding. That is a declarative knowledge and a knowledge of how to act. Implicit (hidden) or, as it is also termed, tacit knowledge, is the knowledge unsaid and not easy to articulate, it is more intuitive, experiential and practical. It is hard to transmit fully as no verbalization is sufficiently all inclusive (e.g. piano playing, bike riding, motor or tap repair, rhetorical ability, selling skill).

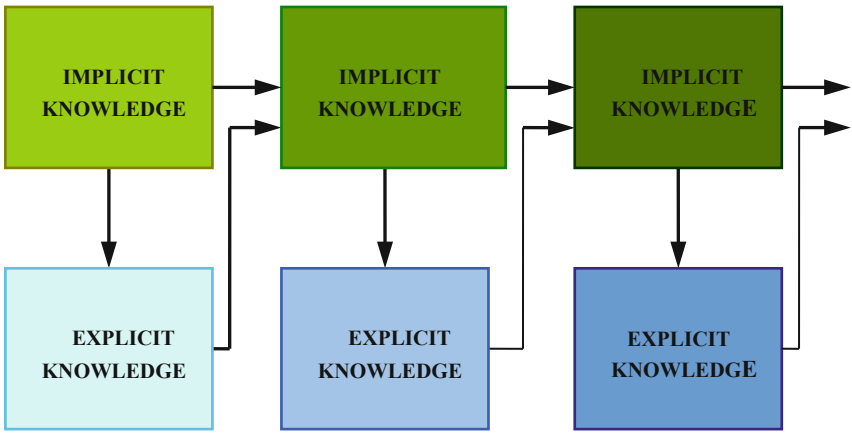

Fig. 1. Interrelation between implicit and explicit knowledge

Knowledge is transmitted by an interaction between implicit and explicit form of knowledge whereby explicit knowledge is, by its nature, much easier to transmit than implicit knowledge (Fig. 1) [13]. The Fig. 1 presents the link between implicit and explicit knowledge, i.e. that explicit knowledge is not possible without implicit knowledge. Implicit (tacit) knowledge is what in fact makes a competitive advantage of an organization when compared to other, because it is hard to imitate, has a specific content and straightforward practical value.

4 Challenges of HRM in the Knowledge Economy

The issue about knowledge is that it is difficult to quantify and control and therefore hard to manage. Part of knowledge of an organization is possessed by its employees, and part by the other part of the organization. It is undisputed that employees participate in organizational knowledge with what they know and do, but the organization itself is involved in a certain way in shaping both the knowledge and capabilities of its employees.

In facing the challenges of the knowledge economy, organizations need to transform their HRM function by leaving behind (free from) the restraints of the past and enable HRM to assume a new role to help steward human capital, facilitate and improve processes, i.e. work as catalyst, establish links and relations and succeed as rapid deployment specialist [14]. HRM has a key role in creating and maintaining a culture that cherishes innovation, creativity and learning. This implies that companies do not treat HRM either as a cost function or profit centre, but as an investment centre.

Storey and Quintas (2001) identified five key challenges for human resources management in the knowledge economy. These are [15]: Development and support of the organizational culture of knowledge, learning and innovation; Finding hidden (tacit) knowledge; Creating conditions for trust and collaboration; Finding ways for employees who do not fall within traditional categories of professions, yet who are important to the organization due to their knowledge and talent (knowledge workers) to fit in within the organization and Organizational reviewing and readiness to change, reallocation of power within organization and encouraging greater independence of key knowledge workers.

Only the holistic approach and HRM, against an unrestricted support of top management and active collaboration of managers of all functions and levels who are to accept the HRM approach with equal enthusiasm, could ensure the fulfilment of an ultimate requirement to survive on the market, i.e. to create and share knowledge and to utilize it. Due to that, the development and training of employees as an HRM tool is highly ranked on the value scale of any organization seeking its place in the knowledge society [13].

Employee development and training as an instrument of human resource strategic management should enable acquisition, sharing, valuation and utilization of knowledge, both explicit and implicit (tacit) at the individual, group and organizational level. That is a continuous process that is managed and involves creativity and innovation. It is experiential and is accomplished through action learning. It primarily refers to the knowledge workers, but to all other employees within an organization as well. The process of training and development conceived this way is supported by the organizational vision and the vision of human resources management as a function that is gaining in importance and has a key role in the knowledge economy in which employees in organizations are placed in the very focus of business activities.

It is challenging to enable organizational action of the knowledge workers who put their profession as priority. Successful organizations are trying to respond to this challenge by [16]: Creating a learning environment that would meet their desire to acquire knowledge; Building locations of voluntary cooperation and Treating people as an “unlimited potential” of competitive advantage, as inexhaustible sources of ideas (Handy, 1997), potentials that are not an expense to be reduced or an asset to be controlled.

In the learning process people change not only their own knowledge contained in cognitive structures, but their behaviour as well. A change in behaviour inevitably results from a change in cognitive structures of individuals, as well as in collective cognitive structures within organization. The authors dealing with organizational learning agree that a mere accumulation of new knowledge and changes in cognitive structures of organization members implicated by new knowledge are not sufficient to conclude that it is about a new organizational learning. For that it is necessary that a change in the consciousness of people also triggers a change in their individual behaviour, as well as collective actionsto lead to some (positive) effects for their organization [17].

5 Conclusion

Due to a transformation into a knowledge society, HRM in organizations is presently seen as a key competitive advantage and is involved to a great extent in making strategic decisions and their implementation. Human resource management is an integral part of the global strategic management of an organization. As such, it acts globally at the operating level, not in isolation.In practice, HRM is carried out through inter-connected elements that make a consistent whole necessary for the realization of HRM strategies and global organizational strategies.

As organizations shift from a traditional training concept to a concept of training and development of all employees, i.e. learning as a way of survival of organization and learning as a lifestyle of employees, it is necessary to shift a focus in it to enabling and facilitating the learning process rather than to the control of that process. Employees should be motivated and accept a stimulus to learn, to transform from a position of being dependent on organization to independence, from passive and reactive learning to active and proactive, in other words, from seeing learning as a one-off activity that is to be taken care of by others and that is the responsibility of others (managers and organization) to a continuous lifelong self-directing learning.

Acknowledgements. This research (paper) has been supported by the Ministry of Education, Science and Technological Development through the project no. 451-03-68/2020-14/200156: "Innovative scientific and artistic research from the FTS (activity) domain".

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Optimization of Cutting Parameters for Surface Roughness in the Ball-End Milling Process Using Genetic Algorithm

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Abstract. The aim of this is to demonstrate the possibilities of applying a genetic algorithm to optimize the input parameters of the ball-*end* milling process when machining hardened steels as a function of the minimum surface roughness. The experimental investigations were carried out using a four-factor experimental design. RSM was used to determine the basic relationship between the input parameters of the process (spindle speed, feed per tooth, axial and radial depth) and the surface roughness. The developed second-order model was used as a reference model for the GA application. The obtained GA model of surface roughness was a function of the goal of the genetic algorithm, which required finding a minimum value of surface roughness Ra. Based on certain optimal values of the input parameters, a confirmation experiment was performed. The measured value of the surface roughness showed a good agreement with the value obtained by GA. The results obtained show the efficiency of the GA application for modeling and optimization of ball-end milling processes.

Keywords: Optimization · Ball-end milling process · Genetic algorithm

1 Introduction

The ball-end milling of hardened steels is increasingly being applied in many industries (automotive, die and mold making, aerospace, etc.). The increase in the use of this machining in the metalworking industry is related to its efficiency, productivity and quality of the machined surface. This machining is particularly interesting for achieving complex surfaces in 3- and 5-axis milling [1]. The cutting geometry of ball-end cutters is very specific compared to other types of milling tools. For the reasons mentioned above, many scientists have been investigating this process over the last decades and have found complex relationships between input variables and output performances of the machining process.

When optimizing systems and machining processes, the selection of the parameters of the machining process is a key task for the success of the machining. The choice of

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 465–472, 2022.
http://doi.org/10.1007/978-3-030-97947-8_61

machining parameters is usually based on the assessment and experience of people (or production engineers). However, the machining parameters selected in this way do not lead to good results. The reason for this is that the machining process is influenced by many factors that prevent the high performance and quality of the process from being achieved in practice.

Optimization algorithms can be divided into conventional and unconventional algorithms [2]. Unconventional optimization algorithms are mainly based on biological, molecular or neurological phenomena that mimic the metaphor of biological evolution and/or social behavior of different species of living organisms in nature. To effectively mimic the behavior of these species, researchers have developed computer systems that seek fast and robust solutions to complex optimization problems. Examples of these systems are Genetic Algorithm (GA), Simulated Annealing (SA), Particle Swarm Optimization (PSO), Artificial Bee Colony (ABC), Ant Colony Optimization (ACO), etc.

The surface roughness is one of the most important parameters for determining the quality of a product and a factor that has a major influence on production costs. Surface roughness in ball-end milling is influenced by a number of factors: machining parameters (cutting conditions, cutting fluid, and process kinematics), material properties (hardness), cutting tool properties (tool material, tool shape, nose radius, run-out error), cutting phenomena (friction in the cutting zone, cutting force fluctuations, acceleration, chip formation). The correct selection of cutting conditions is very important in ball-end milling due to the complexity of the process. The aim of this paper is to show the possibilities of applying a genetic algorithm to optimize the cutting parameters in ball-end milling process (spindle speed, feed per tooth, axial and radial depth) in the finish processing of hardened steels as a function of the minimum surface roughness.

2 Literature Review

Many researchers have proposed different methods, conventional and unconventional, to determine the optimum values of cutting conditions as a function of the minimum value of surface roughness in various machining processes. A number of studies are concerned with modeling and optimizing surface roughness in ball-end milling.

Dhokia et al. [3] modeled the surface roughness R_a in ball end milling of polypropylene using a genetic algorithm. The experimental tests were performed according to the orthogonal array design L_{16}. The model obtained GA showed good accuracy, as the mean deviation between the calculated and experimental data was less than 8.43%.

Vakondios et al. [4] investigated how the machining strategy affects the surface roughness of a single aluminum alloy. For different machining strategies, the cutting parameters (axial and radial depth of cut, feed rate, inclination angle) were varied for both down and up milling. Mathematical models for surface roughness under different machining strategies were obtained by regression analysis, and their adequacy was verified by ANOVA analysis. The polynomial models obtained are of third order.

Hossain and Ahmad [5] used Response Surface Methodology (RSM) and Adaptive Network- based Fuzzy Interface System (ANFIS) models to predict surface roughness in ball-end milling. The results obtained show that the ANFIS model predicts surface roughness with greater accuracy than Response Surface Methodology.

Sekulić et al. [6] applied Response Surface Methodology (RSM), Genetic Algorithm (GA), and Grey Wolf Optimizer (GWO) algorithm for predicting surface roughness in ball- end milling of hardened steel. The prediction models developed using the nature-inspired algorithms (GA and GWO) showed good possibilities for predicting the surface roughness in ball end milling.

Kuram and Ozcelik [7] investigated the multi-objective optimization in the ball-end micro-milling process. The effects of spindle speed, feed per tooth and depth of cut on tool wear, forces and surface roughness were investigated. The multi-objective optimization was performed using Taguchi-based gray relational analysis to find the optimal combination of process input parameters to obtain minimum values of surface roughness Ra, cutting forces Fx and Fy, and tool wear.

Kumar et al. [8] applied a genetic algorithm to find the optimal values of spindle speed, feed per tooth and depth of cut as a function of the minimum surface roughness Ra. Based on the Box-Behnken design of experiment, a Response Surface Methodology was applied to obtain a model of surface roughness. This model was objective function for Genetic Algorithm. The validation of the experiment with optimally adjusted parameters was confirmed with an error of 8.88%.

3 Experimental Procedure and Results

The procedure for determining the optimum values of cutting conditions as a function of the minimum surface roughness consists of three parts:

1. planning and conducting experiments,
2. finding a suitable model for determining the surface roughness using RSM and ANOVA, and
3. optimizing the cutting parameters using GA.

Experimental tests were carried out in the factory "ELMETAL" Ltd. from Senta and in the Laboratory for conventional machining technologies at the Faculty of Technical Sciences [10].

The tests were performed on a vertical CNC milling machine HAAS VF-3YT. The workpiece material was hardened steel X210CR12 with hardness 58 HRC. Emuge-Franken ball-end milling cutters (type 18771A, d = 6 mm, double-edged solid carbide cutters with TiAlN-T3 coating) were used as cutting tools. The workpiece dimensions were 300 mm × 58 mm × 20 mm. The workpiece was further machined by dividing the work area into 84 fields with the dimensions 15.33 mm × 3 mm. Each field served as a single test point. The surface roughness of the machined surface was measured using the portable MarSurf PS1 instrument.

The input independent parameters were spindle speed, feed per tooth, axial depth of cut and radial depth of cut. The tests were conducted according to a Central Composition Design (CCD), which included 30 experiments. The values of the cutting conditions were defined based on the properties of the workpiece material and the cutting tool as well as the recommendations of the tool manufacturer itself. Each input parameter was varied in five levels. The machining parameters and their levels are listed in Table 1.

Table 1. Machining parameters and their levels.

Parameters	Levels				
Spindle speed, n (min^{-1})	3981	4777	5573	6369	7169
Feed per tooth, f_z (mm/tooth)	0.018	0.024	0.030	0.036	0.042
Axial depth of cut, a_p (mm)	0.04	0.08	0.12	0.16	0.20
Radial depth of cut, a_e (mm)	0.20	0.40	0.60	0.80	1.00

Spindle speed is determined by equation below:

$$n = \frac{v}{2 \cdot \pi \cdot \sqrt{a_p \cdot (d_1 - a_p)}} \tag{1}$$

where v is the cutting speed, a_p is the axial depth of cut and d is diameter of the tool.

The measured values of surface roughness for all 30 experimental points are shown in Table 2.

3.1 Modeling of the Surface Roughness by RSM and Determination of Suitable Model Type Using ANOVA

Response Surface Methodology (RSM) is a set of statistical and mathematical methods useful for modeling and optimizing engineering problems. It is a simple, widely used method for studying the relationship between independent process performance (response) and dependent process input parameters. RSM provides a wealth of information from a small number of experiments. Design Expert Software has been used for statistical processing of experimental data with RSM. The goal of the modeling was to establish the relationship between surface roughness and the input parameters of the ball-end milling process such as spindle speed, feed per tooth, axial depth of cut and radial depth of cut. The adequacy of the models obtained and the significance of the input parameters were determined by ANOVA analysis.

The analysis of variance (ANOVA) shows that the reduced second-order quadratic model is best suited for predicting surface roughness [6]:

$$R_{a(RSM)} = 0.95 - 1.85 \cdot 10^{-4} \cdot n + 1.53 \cdot f_z + 0.26 \cdot a_p - 0.85 \cdot a_e + 5.76 \cdot a_e^2 \tag{2}$$

ANOVA is shown in Table 3. The p-value is lower than 0.05, which proves that the model is considered appropriate at the 95% confidence level. The p-value was calculated for all parameters of the proposed model. Based on the calculated p-values, it can be concluded that the radial depth of cut ae ($p < 0.0001$) has the greatest influence on surface roughness.

Table 2. Experimental results for surface roughness.

Trial No.	Code					Parameters				Measured value
	x_0	x_1	x_2	x_3	x_4	n (min^{-1})	f_z (mm/z)	ap (mm)	a_e (mm)	R_a (μm)
1	1	−1	−1	−1	−1	4777	0.024	0.08	0.40	0.745
2	1	1	−1	− 1	−1	6369	0.024	0.08	0.40	0.305
3	1	−1	1	−1	−1	4777	0.036	0.08	0.40	0.643
4	1	1	1	−1	−1	6369	0.036	0.08	0.40	0.497
5	1	−1	−1	1	−1	4777	0.024	0.16	0.40	0.662
6	1	1	−1	1	−1	6369	0.024	0.16	0.40	0.569
7	1	−1	1	1	−1	4777	0.036	0.16	0.40	0.850
8	1	1	1	1	−1	6369	0.036	0.16	0.40	0.425
9	1	−1	−1	−1	1	4777	0.024	0.08	0.80	3.370
10	1	1	−1	−1	1	6369	0.024	0.08	0.80	3.040
11	1	−1	1	−1	1	4777	0.036	0.08	0.80	3.302
12	1	1	1	−1	1	6369	0.036	0.08	0.80	3.149
13	1	−1	−1	1	1	4777	0.024	0.16	0.80	3.261
14	1	1	−1	1	1	6369	0.024	0.16	0.80	3.116
15	1	−1	1	1	1	4777	0.036	0.16	0.80	3.379
16	1	1	1	1	1	6369	0.036	0.16	0.80	3.113
17	1	0	0	0	0	5573	0.030	0.12	0.60	1.677
18	1	0	0	0	0	5573	0.030	0.12	0.60	1.518
19	1	0	0	0	0	5573	0.030	0.12	0.60	1.571
20	1	0	0	0	0	5573	0.030	0.12	0.60	1.296
21	1	−2	0	0	0	3981	0.030	0.12	0.60	1.926
22	1	2	0	0	0	7166	0.030	0.12	0.60	1.159
23	1	0	−2	0	0	5573	0.018	0.12	0.60	1.334
24	1	0	2	0	0	5573	0.042	0.12	0.60	1.299
25	1	0	0	−2	0	5573	0.030	0.04	0.60	1.324
26	1	0	0	2	0	5573	0.030	0.20	0.60	1.285
27	1	0	0	0	−2	5573	0.030	0.12	0.20	0.245
28	1	0	0	0	2	5573	0.030	0.12	1.00	4.258
29	1	0	0	0	0	5573	0.030	0.12	0.60	1.470
30	1	0	0	0	0	5573	0.030	0.12	0.60	1.471

3.2 Modeling of the Surface Roughness by Genetic Algorithm (GA)

RSM was used to determine the basic relationship between the entered process parameters (spindle speed, feed per tooth, axial and radial depth of cut) and the surface roughness. The developed second-order model served as a reference model for the later application of GA. GA is a meta-heuristic method that mimics the process of natural evolution to find the solution space. This method uses three types of operators: selection, crossover and mutation. The key to selection in the genetic algorithm is the fitness function. GA in the modeling process allows to obtain the required model based on the predefined model

shape. The general shape of the reduced second-order model (Eq. 2) was indirectly used as an objective function in ball-end milling process.

The fitness function is defined as:

$$\Delta = \frac{1}{n}\sum_{i=1}^{n}\frac{|E_i - G_i|}{E_i}\cdot 100\% \tag{3}$$

where n is the size of sample data, E_i the measured R_a and Gi predicted R_a calculated by GA.

It is necessary to find a minimum value for this function, since in this way one obtains the smallest error of the model obtained by the genetic algorithm in relation to the experimental data. GA model was created by GA Tool in MATLAB using the experimental results from Table 2. The model developed to predict the surface roughness Ra using GA is [6]:

$$R_{a(GA)} = 1.48 - 1.85\cdot 10^{-4}\cdot n + 4.75\cdot f_z + 0.79\cdot a_p - 3.94\cdot a_e + 8.8\cdot a_e^2 \tag{4}$$

The predicted values for surface roughness as obtained in GA were compared with experimental values. The model accuracy of the GA model (Eq. 4) was 91.78% [6], which is a good agreement with experimental data.

Table 3. ANOVA for response surface.

Response	R_a						
ANOVA for response surface							
Analysis of variance table [Partial sum of squares - Type III]							
Source	Sum of squares	df	Mean square	F value	p-value prob > F		PC (%)
Model	37.24	5	7.45	140.10	<0.0001	Significant	
A-n	0.52	1	0.52	9.78	0.0046		1.35
B-fz	2.017E−03	1	2.017E−03	0.038	0.8472		0.01
C-ap	2.521E−03	1	2.521E−03	0.047	0.8294		0.01
D-ae	35.19	1	35.19	661.90	<0.0001		91.36
D^2	1.53	1	1.53	28.72	<0.0001		3.96
Residual	1.28	24	0.053				3.31
Lack of fit	1.20	19	0.063	3.93	0.0677	Not significant	3.10
Pure error	0.080	5	0.016				0.21
Cor total	38.51	29					100
	$R^2 = 0.9669$; Adj $R^2 = 0.9599$						

4 GA Based Optimization of Ball-End Milling Parameters

GA allows to obtain optimal values of input parameters based on the previously developed Eq. 4. This equation is an objective function of the genetic algorithm for which

it is necessary to find the minimum value of surface roughness. The limits of the range in which the optimal values were sought were determined on the basis of the data in Table 1.

The limits of the range are:

$$3981 \leq n \leq 7166$$
$$0.018 \leq f_z \leq 0.042$$
$$0.04 \leq a_p \leq 0.20$$
$$0.2 \leq a_e \leq 1.00$$

The optimum values of the cutting parameters and the minimum surface roughness Ra obtained by GA optimization are given in Table 4. Table 4 also shows the comparison between the GA result and the surface roughness value measured after the confirmation test. The good agreement between GA result and measured surface roughness shows the effectiveness of the proposed optimization method.

Table 4. Results of GA optimization.

Optimal values of input cutting parameters					
R_a [μm]		n [min $^{-1}$]	f_z [mm/tooth]	a_p [mm]	a_e [mm]
GA result	0.180	7166	0.018	0.04	0.23
Measured value after confirmation test	0.206				

5 Conclusions

In this paper the application of the optimization GA method for the determination of optimal cutting parameters in ball-end milling process was shown. The objective function was to minimize the surface roughness. For the application GA in the optimization of machining parameters it is necessary to predefine a mathematical model of surface roughness. RSM and ANOVA were used to determine an adequate mathematical model that establishes the basic relationship between the surface roughness and the cutting parameters of the ball-end milling process. The defined second-order model was used as a reference model for the later application of GA. The newly created GA model was obtained using GA Tool from MATLAB. The resulting GA model showed good accuracy in predicting surface roughness. This was an important prerequisite for the further process of determining optimal values of cutting parameters with GA. After determining the optimal values of the cutting parameters, a verification experiment was performed. The measured value of the surface roughness after the verification experiment showed a good agreement with the value obtained previously by the GA optimization procedure.

GA optimization method presented in this paper have a potential to improve the initial process parameters to achieve the minimum value of surface roughness in ball-end milling process with high accuracy, which was clearly verified by the confirmation test.

Acknowledgment. This paper has been supported by the Ministry of Education, Science and Technological Development through the project no. 451-03-68/2020-14/200156: "Innovative scientific and artistic research from the FTS (activity) domain".

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Process Mining in Public Procurement in Croatia

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Abstract. Generally speaking, public procurement processes present an important topic because the presence of anomalies reveals opportunities for fraudulent activities. Given the amount of money invested in public procurement in the EU, it is crucial to know how it is spent. We describe the current state of the art in terms of public procurement in Croatia, and we employ process mining to analyze public procurement procedures.

Keywords: Process mining · Fraud · Public procurement · Business intelligence

1 Introduction

Public procurement (PP) is a process through which the state purchases work, goods, and services. In most countries, it is defined by the Public Procurement Act. Spending public money is always a focus of interest for state citizens. Yearly, at the EU level, 250,000 public authorities spend more than 2 trillion Euro in terms of different procedure types, such as open, restricted, and negotiated procedures, auctions, etc., for which different public procurement rules are applied [1]. The various rules result in varying processes that have many possibilities for corruption, making fraud detection difficult [2]. To fight against public corruption, multiple techniques are employed that regulate the public procurement process by using different questionnaires and establishing control over the process. Although there are stringent restrictions that have been put in place by public procurement laws, these are insufficient in helping to detect fraud in public procurement [3]. For example, the telecommunication, insurance, and banking industries are areas where corruption detection presents a challenge because they require time and domain knowledge in various areas, including law, finance, commerce, and others [4].

Recent studies have mostly focused either on the development and implementation of predictive models or the detection of relationships between economic operators and public bodies. The models created to detect public procurement (PP) corruption are based on historical data mainly focused on its classification or clustering. Researchers have used supervised and unsupervised learning methods to detect fraud, which may be subjected to process analysis in later steps [5, 6]. This study aims to provide government bodies with a risk assessment and insight into suspicious tenders or into identifying potential

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 473–480, 2022.
http://doi.org/10.1007/978-3-030-97947-8_62

cartels, collusion behaviors, or risky relationships between economic operators [7–9]. There are many corruption indicators, and the question is how to choose and implement the right one. Thus, studies have been related to the elicitation of domain knowledge and performing different inquiries to find models for automating fraud detection and performing advanced searches for corruption indicators [3, 9, 10]. The different types of data provided by companies can be used to flag attributes that can help determine the risk of corruption [11–13].

Previous studies have raised questions related to dilemmas about the events, attributes, data, or even entire processes that seem to be suspicious. As such, the calculation of corruption risk or classification process should be based on a target variable, such as the "number of bids." In the literature, researchers have argued that tenders with one bid are suspicious, harmful, or risky because if one is obeying the law, there is only a small likelihood that the contract will have only one bidder, especially if one is using the standard "open" PP procedure, where each economic operator can participate. Of course, we cannot claim that any specific public procurement procedure is corrupt, but we should try to minimize the possibility of the risk of corruption.

Public procurement consists of five phases: planning, budgeting and procurement preparation, publication, information and the evaluation of tenders, and contract bidding and execution [14]. The PP law regulates each process, but many business rules need to be implemented by any information system. The time frames between the activities are also regulated by law. For example, in Croatia, a public body must conclude a contract within 30 days of opening the bids, unless an appeal arises. Sometimes the contract is concluded immediately (i.e., in the beginning), and in some cases in the last two or three days. Is there any connection or correlation between the timing of the events and the fact that an individual tender has only one bid?

In our previous research, we focused on one-bid tenders. We used data mining techniques to detect suspicious one-bid tenders using publicly available data in Croatia. In our first study [15], we aimed to detect, extract, and use textual content from PP tender documentation, and to use different machine-learning algorithms to try to detect any indications of corruption in the public procurement process. The study concluded that machine-learning methods and text-mining techniques could detect signs of corruption in the public procurement process by using the content of the tender documentation. We extend this research by finding other textual terms of interest to check how extracted "enriched" content can impact the prediction results. For this purpose, a set of terms was defined, and each PP tender documentation section that contained any of the terms was extracted [16]. This model, which has new pre-processed data, had better results with the same machine learning methods.

In this study, we are using process mining to see if there is a difference in process execution between (suspicious) one-bid tenders and tenders that have more than one bid. More specifically, we are interested in whether there are any differences in the duration phase for tenders that have one bid and tenders that have more than one bid. Moreover, we are interested in analyzing particular public procurement procedures, and we are interested in what process mining can offer in analyzing them. Furthermore, we look at how to apply process mining, which is challenging since we do not have a large amount of publicly available data.

The rest of the study is organized as follows. In the next section, we introduce the basics of process mining. After that, we describe how we have used process mining to analyze PP data in Croatia. Then, we provide some ideas for future research directions, and, in the end, the conclusion is presented.

2 Process Mining

The idea behind process mining is to discover, monitor, and improve real processes by extracting knowledge from event logs that are available in modern information systems [26]. Process mining encompasses techniques for the automated discovery of process models [22]. The method of automatic process discovery is to use event logs that are stored in information systems [17, 19]. Event logs are event data that "have to be recorded in such a way that each event can be exactly related to three things: an individual case of the process, a specific activity of the process, and a precise point in time" [19]. The discovery techniques usually require that the event log fits in the main memory and has been completed [20]. Events within a case are ordered, and they can have certain attributes [23]. Events can have different characteristics. Mandatory characteristics are the kind of activity and the timestamp, while other standard characteristics are "the resource used to perform the activity, transactional information (start, complete…), and costs" [24]. Other references include [18, 21] and [24].

Process mining, in connection with BI, substantially provides innovations for the next generation of BI techniques [23]. There are minor techniques that discover process models in high-level languages like BPMN or event-driven process chains (EPCs) [22]. We have also implemented a small BI solution on the data, and Fig. 1 shows the BI report on the PP data. The focus of process mining through BI tools is on "querying and reporting combined with simple visualization techniques showing dashboards and scorecards" [23]. Approaches exist that combine process mining with online analytical processing (OLAP) tools to create and analyze process cubes filled with event data [23]. Management dashboards provided by BI systems record the execution of process instances in the event logs [25]. However, BI usually aggregates a large number of records in reports (BI uses the GROUP BY clause and some aggregation functions), and the focus is not on particular records. In process mining, each particular process can be analyzed, variants can be identified, and the basic statistics are presented, etc., as we show later on.

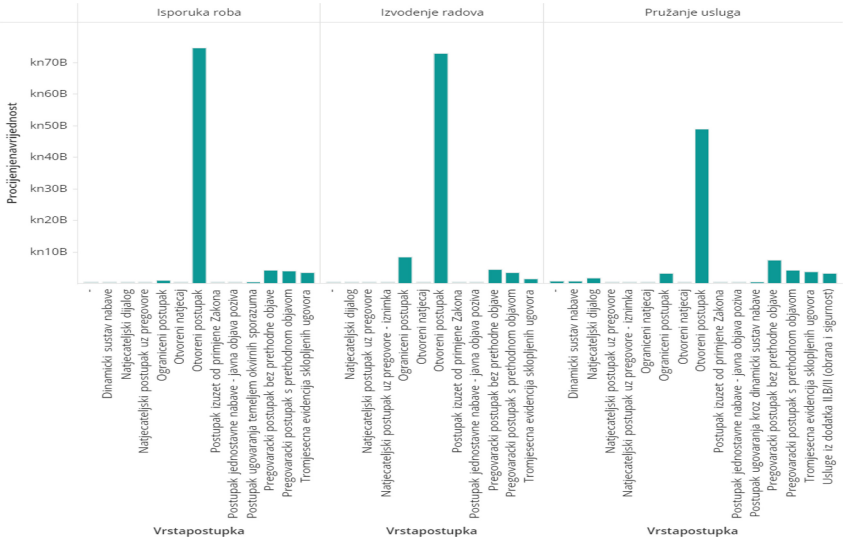

Fig. 1. BI report

3 Process Mining in Public Procurement

Now we can describe how we have used process mining to analyze the PP data in Croatia. We should note that many challenges had to be solved. In terms of the Public Procurement Law in Croatia, all notices about the procurement process need to be publicly available on the Electronic Public Procurement Classifieds of Croatia in a machine-readable format, XML. Thus, we manually downloaded this data, preprocessed the data, and saved the data with a Python script using the ElementTree XML API. For data storage, Microsoft SQL Server was used (Fig. 2).

ID	UlogaPartnera	VrstaJavnogNarucitelja	DjelatnostNarucitelja	NacinNabaveId	PredmetNabave	VrstaUgovora	VrstaPostupka	Procij
10...	Javni narucitelj	Pravne osobe koje su osn...	, Ostalo: TEHNICKO ISPI...	1	NAJAM MICROSOF...	Pružanje usluga	Otvoreni postupak	3200
10...	Javni narucitelj	Pravne osobe koje su osn...	, Ostalo: TEHNICKO ISPI...	1	javna govorna uslu...	Pružanje usluga	Otvoreni postupak	2800
10...	Javni narucitelj	Pravne osobe koje su osn...	Obrazovanje	NULL	Uredske potrepštine	Isporuka roba	Otvoreni postupak	2000
10...	Javni narucitelj	Pravne osobe koje su osn...	Zdravstvo	NULL	Obrasci, tiskanice i ...	Isporuka roba	Otvoreni postupak	1869
10...	Javni narucitelj	Pravne osobe koje su osn...	Zaštita okoliša, Stamben...	1	Asfaltna masa	Isporuka roba	Otvoreni postupak	9000
10...	Javni narucitelj	Pravne osobe koje su osn...	Zdravstvo	NULL	TESTOVI I DODAT...	Isporuka roba	Otvoreni postupak	8791
10...	Javni narucitelj	Pravne osobe koje su osn...	, Ostalo: Upravljanje luka...	NULL	RADOVI NA DRUG...	Izvodenje radova	Otvoreni postupak	3200

Fig. 2. Source data

For this research, we selected the process mining tool named Disco. Using the tool, one procurement procedure is called a case, and one case can have more than one event. In our scenario, each case had three events: “announced,” “submission deadline,” and “contract signed.” Within the Disco tool, there are different diagrams available. The next figure shows the active cases over time (Fig. 3). Here, one can filter the data, but it is possible to find the peaks when the most PP procedures were active. We can also see the number of active cases over time, as well as the procedure duration time. For example, one procedure lasted 97 days, while another lasted only 25 days (Fig. 4):

Fig. 3. Active cases over time

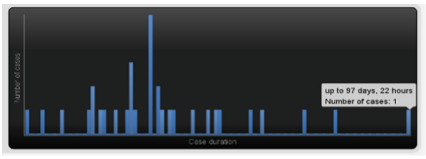

Fig. 4. Procedure duration

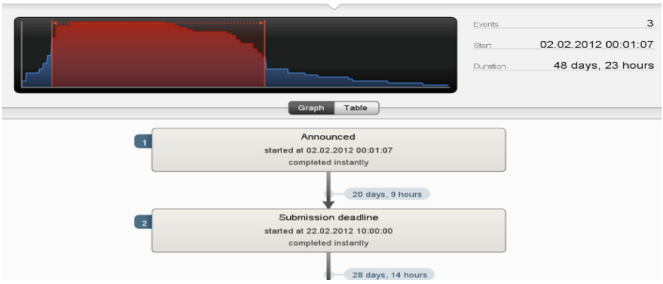

Fig. 5. Statistics for a particular case

One can also explore each particular PP case. For each case, one gets all the important dates and the duration for each phase (Fig. 5).

This was interesting for us since we had a few potentially suspicious one-bid tenders. Thus, we were able to analyze such cases. First, we focus on the one-bid tenders.

3.1 One Bid Tenders

In the data preparation phase, we split the data into two groups: one-bid tender data and tender data for multiple bids. In the next figure, one can see a histogram that represents the duration for the selected one-bid tenders (Fig. 6), as well as for the bid-tender process flow (Fig. 7).

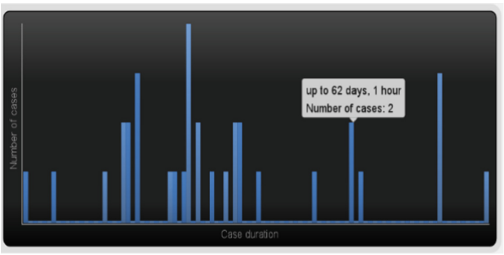

Fig. 6. One bid tender – duration per case

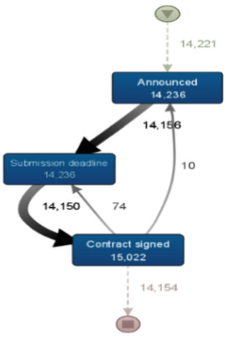

Fig. 7. One bid tender process flow

The analysis shows that some one-bid tender procedures lasted more than three years, which is a bit unusual and should be examined more closely (Fig. 6). The mean case duration for one-bid tenders is 81.5 days, and the median case duration for one-bid tenders is 57 days. One can also see a process flow for the one-bid tenders (Fig. 7).

3.2 Tenders with More Than One Bid

Next, we analyzed the tenders that had more than one bid. The case duration is already presented in Fig. 4. For tenders that had more than one bid, the median case duration is 71 days, and the mean case duration is 15.3 weeks. We can see that the case duration is longer than for one-bid tenders, and some tenders took three years to complete. We can also see that the median and the mean are longer than for the one-bid tenders (Table 1).

Table 1. Mean and median duration values for one- and multiple bid tenders

	One bid tenders	Multiple bid tenders	Change (%)
Mean (days)	81,5	107	+31,2%
Median (days)	57	71	+24,5%

Another critical thing to note is that the tool also recognizes different variants, i.e., different activity patterns that can be identified based on the data set. For one-bid tenders, there are 14 different variants, and, for multiple bid tenders, there are 16 different variants that have been identified. This should be explored more closely (Fig. 8).

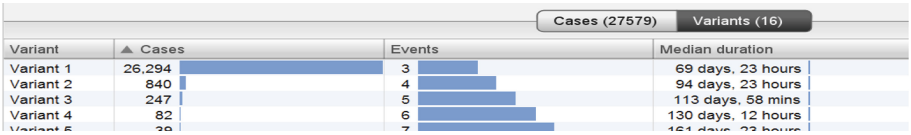

Fig. 8. Variants

4 Future Research

In this study, we focus on the process mining side of the PP procedures, and we tried to determine whether there is a difference in the duration phase for one-bid tenders and multiple bid tenders. In our next study, we will try to combine the results from our previous research, i.e., we would like to combine the technical documentation analysis and data mining techniques for one-bid tenders with the process mining part, but while using a much more considerable amount of more complete data. By "more complete data," we mean the data that has more relevant dates, i.e., events, such as, for example, the change date (which denotes whether the procedure has been changed), the data for when the documentation was updated, the date when the company that signed the contract was established, etc. This will bring us closer to detecting suspicious tenders since we could combine both data and process mining techniques for this purpose.

5 Conclusion

In this study, we have described the current state of the art in public procurement in Croatia. There is a clearly defined concept for a single-bid tender that is highly suspicious. It is challenging to process and prepare the data for analysis, but we managed to apply the process mining method to our data. The results show that one-bid tenders require less time to complete than the procedures that have more than one bid (the mean and median values are smaller for one-bid tenders). Since we have a list of a few suspicious cases, we examined those cases, and, for one suspicious case, we see that the contract was signed exceptionally fast. However, we cannot reveal the details.

Given that this research was done on a limited data set, one of the next steps would be to test our ideas on a more complete data set. We would add more cases and events. However, the problem is that the data is not available, or special permissions are required. Moreover, we would like to combine the technical documentation data analysis and data mining techniques with the process mining results.

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The Influence of COVID 19 Pandemic on Cogeneration Biogas Plant Operation - Business Impact Analysis

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Abstract. Cogeneration biogas plants are complex systems which have a function of simultaneous production of heat and power (CHP) converting the chemical energy of biogas into electrical and heat energy, using an engine connected to the generator.

Managing these systems in normal conditions is very complex, caused by various challenges and problems such the organization of crop rotation, livestock diseases, oscillations of biogas in the substrate, rising prices of raw material, maintenance of the technological process, potential equipment failures and repairs which stop the entire production process.

Today, after the outbreak of the COVID 19, the question arises as to, how companies and investors in biogas business could operate within difficult circumstances and events that suddenly appear.

This paper explores the impact of COVID 19- biohazard and its consequences on CHP plants operation. Therefore, risk assessment technique - Business impact analysis is important for understanding operational, organizational, financial and legal impacts. The paper analyses criticality of key business processes, functions and resources; how disruptive event (COVID 19) affects business objectives, and what is the capability of a company to recover from an incident caused by biohazard.

At the end of the paper, the authors consider recovery strategies for similar future events.

Keywords: Cogeneration biogas plants (CHP) · Business impact analysis (BIA) · Biohazard COVID 19

1 Introduction

The production and application of biogas have developed in the last 20 years. A biogas plant is a system built for production, storage and application of biogas. It includes all facilities, equipment, installations and infrastructure required for operation, and it represents the technological basis for producing of electricity, heat, cooling energy and high-quality fertilizer. “A combined heat and power (CHP) plant is used to convert chemically stored energy from biogas to electricity and heat through a motor connected to a generator” [1].

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 481–488, 2022.
http://doi.org/10.1007/978-3-030-97947-8_63

Increased production and application of biogas, is directly related to the adopted stimulating measures (feed-in tariffs) for the repurchase of electricity produced from renewable resources. CHP plants are funded with project finance, through a loan. Consequently, it is possible to pay off extremely valuable investments in energy, network infrastructure and production systems, because the price of electric energy from renewable resources is competitive, compared with fossil fuels.

From a business point of view, it is difficult to generate revenue which is sufficient for the complete fulfilment of obligations and future growth; because there are many problems occur during the normal operational mode from crop rotation, livestock diseases, oscillations of biogas in the substrate, rising of raw material prices, technological process maintenance, potential equipment failures and repairs; which stop the whole production process. Today these problems are joined and complicated with Biohazard COVID 19 caused by coronaviruses.

So, it is important to observe business in normal conditions and conditions of emerging crisis and determine an optimal solution for sustainable development.

2 Business Impact Analysis

Business impact analysis is a tool for understanding the company activities within various trends which can impact business continuity. There are many definitions of business impact analysis, and these bests describe their purpose and objectives.

"Business impact analysis can be defined as the process of studying and analyzing business functions so as to study the effect that these disruptions have on them. Consequences of a disruption can include financial loss, reputational loss, and loss of competitive position these are in addition to the potential loss of staff, loss of data and even loss of access to buildings" [2].

"The process of analyzing business functions and the effect that a business disruption might have upon them" [3].

"It identifies the financial and operational loss of the organization's business functions and processes over periods significant to the individual organization regardless of what caused the loss by examining their impact on service objectives, financial position, cash flow, regulatory and contractual issues, and competitive risk" [4].

"Business impact analysis is process of analyzing the impact over time of a disruption on the organization" [5].

Purpose of business impact analysis is to: plan for accident situations, estimate own resources and apply a proper strategy for continuing the business.

The key objectives of cogeneration biogas plants are to produce and sell electrical energy, thermal energy and high-quality fertilizer. In that processes, the company use installed equipment, a raw material which usually consists of a mixture of corn silage, sorghum silage, sudangrass, sugar beet, straw, and manure obtained by farm cleaning. These organizational objectives companies achieve by applying precisely defined technological procedure and engaging employees to manage and maintain production process.

The Business impact analysis tool, with COVID-19 outbreak, could be used to estimate biohazard impact on business trough:

- Determining critical business activities,
- Calculating financial impact,
- Valuating intangible impact and
- Determining all resources for recovery.

Our research question is how COVID19 outbreak influenced business continuity of cogeneration biogas plants.

3 Analysis

"Widespread occurrence of an infectious disease affects electricity consumption, production, maintenance, operational activities, development plans, etc." [6].

"The pandemic have a tremendous impact on the energy sector, with a plunge in total energy demand, driven by a decline in commercial and industrial activities" [7].

Our study research is focused on biogas CHP plant capacity of 1 MW, which operates on the territory of the Republic of Serbia.

As a good example what could happen in a pandemic situation, we reference Resolution of Ministry of mining and energy (Republic of Serbia) which postponed the effects of the Agreement on the purchase of electricity from privileged producers, after the declaration of the state of emergency, referencing to Force Majeure.

The study research the operation of a biogas CHP plant in normal conditions and the conditions of biohazard; where the impact of biohazard will be present for two years (as an assumption), and business will be interrupted (reduced) within three (3) months, as the worst possible scenario. During these periods the production process will keep to a minimum, so privileged producers won't be disconnected from the network.

The study research biogas CHP plant installed capacity 1 MW. Capital expenditure on investment is € 4,000,000. Structure-sources of financing are divided: 30% own funds-70% loan, and the loan repayment period is 120 months with an interest rate of 5.5%.

The following tables show the data obtained from the research (Tables 1, 2 and 3):

Cash flow, internal rate of return (IRR), payback period (PBP), return on investment (ROI), efficiency ratio, return on assets (ROA) and return on equity (ROE), were observed as relevant indicators.

The analysis of dynamic indicators shows the profitability, through the payback period and the internal rate of return, for business in normal conditions and conditions of biohazard. In normal conditions, the return on investment is between 7 and 8 years, more precisely 7.84 years, and in the case occurrence of biohazard between 8 and 9 years, more precisely 8.84 years. The difference originates in the cash inflow from the sale of electricity, which is in direct relation to an agreement breach by the caused appearance of force majeure, and this reduces the free cash flow.

Internal rate of return represents the maximum discounting, which could load the investment and to keep it profitable, ie this rate represents the limit of profitability of the project regarding the price of invested own funds. In normal conditions, IRR is 10,23% and in the case occurrence of biohazard IRR is 8,10%.

Table 1. List of business process criticality

Name of department	Critical business process	Description
Operations	Procurement	Planting
Logistic	Reception, dispatch and transport	Manure transport Planting and harvesting Organization Solid and liquid fertilizer transportation
Production	Substrate preparation Biogas production Biogas treatment Electrical and thermal energy production and distribution	Sustain the technological process, respecting safety guidelines
Legal and administration	Contract management	Breaching the contracts
Maintenance	Facility management	Maintenance of technological equipment is outsourced

Table 2. Classified impact and ranking criticality

Name of department	Ranking	Recover priority	Maximum tolerable downtime-days
Operations	Critical	High	15
Logistic	Critical	High	15
Production	Vital	High	20
Legal and administration	Important	Medium	60
Maintenance	Critical	High	5

Table 3. Financial indicators

Indicator	Value -normal mode	Value -COVID 19 mode
Efficiency ratio	63,84	80,63%
ROI	9,49%	8,14%
ROE	30,55%	27,06%
ROA	13,18%	11,62%
PBP	7,84	8,84
IRR	10,23%	8,10%

The return on assets represents the ratio between gross profit in one year (business result) and total invested funds. This indicator indicates the efficiency of business activity regardless of the source of funds and the price of borrowed capital. In normal conditions, ROA is 13,18% and in the condition of biohazard ROA is 11,62%.

In addition to these data, the research conducted leads to the conclusion that the company's liquidity in the years in which biohazard occurs decreases by 32,92% and productivity decreases by 26,34%.

4 Results and Discussion

Although biogas companies are small with several employees and have only a few business functions, business impact analysis has shown that with the advent of biohazard, the business of such companies has deteriorated.

The main factors which could impact the business can be observed from three different aspects financial, operational and regulatory.

Financial impact includes:

- Loss of revenue in the period of the state of emergency,
- Delayed revenue after the state of emergency,
- Reduced revenue, due to market instability,
- Decreased cash flow stability,
- Delay payment for raw material,
- Inability to finance subsequent sowing,
- Reduced liquidity.

Operational impact includes:

- Reduced production volume- production continuity,
- Reduced productivity,
- Increasing operational expenses,
- Inability to maintain the plant,
- The decay of raw materials,
- Dependence of suppliers,
- Possibility occurrence of other damages,
- Supply chain management problems- an impossibility to order or receive the material,
- Loss of employees and the absence of key staff- operator.

Regulatory impact includes:

- Breaches in agreement with the electric utility power company,
- Breaches in agreement with maintenance company,
- Delay in tax payment,
- Delay in credit annuity payment,
- Reduced reputation at banks and insurance companies.

5 Business Continuity Strategy

In carried out research and studying different literature, it is not possible to foresee the problems which the pandemic causes, today there is no complete historical data which indicate effects to the economy and day-to-day business, caused by catastrophic events. Business impact analysis represents a useful and necessary tool for monitoring the business of companies. To continue business in uncertain market conditions, which will be changing in the next period, it is necessary to choose the right strategy for future events, i.e. "a plan that is intended to achieve a particular purpose" [8].

The organization is opting for "a strategic approach to ensure its recovery and continuity in the face of a disaster or other major incidents or business disruptions" [3].

"The business continuity is capability of an organization to continue the delivery of products and services within acceptable time frames at predefined capacity during a disruption" [5].

The business continuity strategy should comply with business and renewable energy. In this case, it is a strategy for disaster preparedness and recovery. The business continuity strategy should focus on: measuring and assessing the impact of the pandemic on employees, critical functions and processes, facilities and equipment.

The Business Continuity Plan (BCP) serves as a tool to achieve resilience to a disruptive event. "The Business Continuity Plan is ad documented collection of procedures and information that is developed, compiled, and maintained in readiness for use in an incident to enable an organization to continue to deliver its critical products and services at an acceptable predefined level" [3].

"Business continuity plan documented information that guides an organization to respond to a disruption and resume, recover and restore the delivery of products and services consistent with its business continuity objectives" [5].

Good BC plan will ensure the survival of the organization. So, it is necessary to develop a crisis plan for all business functions.

BC plan for Operations department serves as a guide to:

- Determining the expected interruptions in the supply of raw materials,
- Requesting offers from various cooperators for planting,
- Determining alternative sources for other material supplies.

BC plan for Logistic department serves as a guide to:

- Determining a plan for movement restrictions- transportation and farming,
- Purchasing if fuel shortages happen,
- Improving communication channels.

BC plan for Production department serves as a guide to:

- Rapid decision making,
- Processing of waste and manure from farms,

- Sustaining the production process on a minimum,
- Compliance with safety procedures,
- Technological process control with remote monitoring.

BC plan for Legal and administration department serves as a guide to:

- Covering sick employee absence,
- Compliance with health procedures,
- Protecting the assets,
- Reviewing insurance policy for pandemic impact on employees and business-lost profit
- Annexing agreement with the electrical distribution company, suppliers, and maintenance company.

BC plan for Maintenance department serves as a guide to:

- Ensuring spares on inventory,
- Carrying out video conference calls with the maintenance service.

6 Conclusion

Infectious diseases which had occurred influenced the history and development of human civilizations. Until recently pandemics have been studied mainly by medical historians. A Pandemic, as a worst catastrophic event, must be observed in a broader context. In addition to discovering ways to suppress pandemic, it's impacts must be studied, primarily on: business operations, economic systems, national economies and strategic changes in the development of society.

This paper analyzes the business of companies in the field of renewable energy sources, in the event of a pandemic, during the limited period.

In normal mode, stochastic factors have a minor impact on the biogas industry, because the production of energy, wasn't calculated at average, therefore projected effects don't differ from those achieved.

Under normal conditions, the risks of selling and billing electricity are systematically solved through feed-in-tariffs, the risk of lack of raw materials is conceptually eliminated, and all production issues are solved in detail structurally and organizationally.

But in the case of a catastrophic event appearance, these conditions no longer applicable.

For further actions and survival of the companies, more detailed analyzes should be done and especially those what will include, the future prices of energy, food, transport, labour and market needs and trends that will occur in the post-pandemic period.

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Project Management Skillset Challenges in Industry 4.0

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Abstract. Digital transformation in the manufacturing industry, termed Industry 4.0, has become of strategic importance under exponential technological development. Industry 4.0 is redefining production by aiming to build smart factories through cyber-physical collaboration systems. While Industry 4.0 focuses on the technical aspects, the 4th industrial revolution has a focus on the impact that Industry 4.0 has on manufacturing, but also society as a whole. In a highly competitive world, manufacturing organizations need to be agile when implementing projects to respond quickly to ever-changing market demands. Projects will continue to change in terms of scope and growing complexity. In contrast, project management will continue to involve an irreplaceable combination of skills, leadership, and ethical behavior. What changes and adapts are the skills needed to run a project successfully. Project management is still too focused on "hard" technical skills, which are essential, but people are the ones who manage and implement projects, and that must not be forgotten. Technology alone cannot guarantee the success of projects undertaken, and the human factor should not be overlooked because Industry 4.0 is not only based on technology but also on the creativity of people applying technology. With the growth of complex projects and the increasing pace of change, organizations need project managers and teams to deal with digital transformation, disruptions, frequent changes, and ambiguities. This article focuses on project manager skill set challenges in the context of Industry 4.0, highlighting the importance of people for project success.

Keywords: Project risks · Market conditions · Regression analysis · Project management

1 Introduction

Digital transformation as a new paradigm in the industry is volatile, uncertain, complex, and ambiguous [1]. Termed Industry 4.0, in the manufacturing industry, it has become of strategic importance under exponential technological development. Industry 4.0 is redefining production by aiming to build smart factories through cyber-physical collaboration systems. While Industry 4.0 focuses on the technical aspects, the 4th industrial revolution has a focus on the impact that Industry 4.0 has on manufacturing, but also

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 489–495, 2022.
http://doi.org/10.1007/978-3-030-97947-8_64

society as a whole. Human-machine communication and machine-machine communication represents a core change segment of the 4th Industrial Revolution and the Industry 4.0 concept [2].

In Industry 4.0, which is dominating nowadays, project management plays a significant role in the value chain. The role and skills required from the project managers are changing and have a lot of variations. Successful implementation of Industry 4.0 relays on the development and evolution of jobs and skills [3].

Under the influence of the latest technological and globalization trends, the future path for developing and adjusting project management approaches, followed by competences and skills that project managers need to possess, is of crucial importance to successfully run projects.

In this article, a literature review was conducted using electronic databases: Google Scholar, Science Direct, and Kobson and professional blogs and websites of prominent project management organizations. Databases included research articles published in peer-reviewed journals and conferences from 2013 to 2020. Keywords used in a search process were: Industry 4.0, project management, project manager, project manager skills, and then combined with "or" and "and" operators.

The remainder of the paper is structured as follows. Section 2 gives an overview of project management in Industry 4.0, followed by project management challenges imposed by Industry 4.0. In Sect. 3, the role of a project manager in Industry 4.0 is described, followed by a description of project manager skillset challenges in Industry 4.0, while Sect. 4 gives a discussion and conclusion with suggestions for further research.

2 Project Management in Industry 4.0

Industry 4.0 has been defined as the massive developmental stage in industrial manufacturing, including the entire value chain and management structure. It is built on pillars like innovation, processes automation, and sophistication, using new technology, but without forgetting that the main asset of an organization is its people [4].

Industry 4.0 poses many challenges to project management by considering the competencies and skills needed to be acquired by the project manager to keep pace with new industry needs and expectations. In such a changeable ecosystem, project management has to be affected by influences such as projectification of society, digitalization, virtualization, coping with complexity, transnationalization, professionalization, switch from Waterfall to Agile, etc. [2].

In Industry 4.0, manufacturing companies need to be agile when implementing projects to respond quickly to ever-changing market demands [5]. Agility means preparing changes in the entire value chain to achieve a corporate objective and, therefore, to follow the changes during the project realization. Agility relies on adaptive approaches self-organization in interdisciplinary teams, informal communication, collaboration, and social interaction, and is needed to implement Industry 4.0 technology [6].

2.1 Project Management Challenges in Industry 4.0

The implementation of Industry 4.0 technologies implies organizational changes and challenges in many areas [7]. According to some authors, project management and

Industry 4.0 will impact each other in many ways [4, 8, 9]. Automation will perform repetitive business tasks that do not require analytical and design skills, significantly impacting all employees who don't play a strategic role in project management. As automation takes over simple tasks, companies will have more resources to focus on complex ones. In the new manufacturing structures, vast amounts of data will be available. The difficulty of its acquisition, as it is not all homogeneous, needs to be integrated for sound decision making. For this reason, the independent systems must interconnect and interoperate. Online threats will continuously require effective control to be carried out, utilizing cybersecurity tools and protocols [4].

The advent of the 4th Industrial Revolution requires novel ways of managing project teams [6]. The project teams will be increasingly delocalized, with people interacting from different parts of the world [9], simultaneously with diverse cultural and professional backgrounds. They will be delocalized, but at the same time, their integration will be needed [10]. Standards, methodologies, and risk management become critical in this context.

Jobs created by automation require different experiences and skills than the jobs automation replaces. Project teams will need higher skills than those required in the past—and also a greater degree of autonomy to achieve the best results [9].

3 The Role of Project Manager in Industry 4.0

With the emergence of organizations in Industry 4.0, "connected people" or "professionals 4.0" appear, who are distinguished by being more efficient, more flexible, faster, and, consequently, more competitive, thanks to the total connectivity among machines, systems, and people [4]. Nowadays, most authors agree that project managers need to manage more than just project constraints of time, budget, and scope. They need to be strategic thinkers, leaders and have advanced communication skills depending on each ecosystem and organization structure [1]. To solve new complex problems, project managers need to communicate, share, and use the information, adapt, and innovate in response to new demands and changing circumstances. Leadership is one of the essential features of a project manager. But leadership needs to change as well in the new industrial age. It needs to empower people to think in different ways and collaborate beyond limits, to be more connected, responsive, collaborative, and network-experienced to follow up on new trends in the industry [11]. Although the correct use and application of new technologies have great importance, being open to cultural change plays a significant role in the leadership of Industry 4.0. [11].

To adopt and meet new project requirements in Industry 4.0, project managers and teams will need to develop variant soft and "hard" skills that were not required in the past. Project managers and project teams will have to collaborate closely more than ever before, which implies trust and communication within the collaborative environment. They will have to continuously learn new technologies, resulting in new skills, competencies, and lessons to be learned and mastered.

3.1 Project Manager Skillset Challenges in Industry 4.0

Today's competitive global market and changing work environment demand that project managers possess soft skills in addition to "hard" technical skills. They must be able to understand project goals, to communicate them, and to have the ability to accomplish them with available resources [12], while simultaneously managing and leading teams that need to have high performance. The top six digital-age skills for project delivery according to PMI's Pulse of Profession Report are [13]: (1) data science skills, (2) innovative mindset, (3) security and privacy knowledge, (4) legal and regulatory compliance knowledge, (5) ability to make data-driven decisions, and (6) collaborative leadership skills.

Although project management is still too focused on "hard" technical skills, which are essential, people are the ones who manage and implement projects, and that must not be forgotten. Some authors emphasize and categorize technical "hard" and soft skills as equally important in the new technological age [14]. Soft skills involve interacting and teamwork, communication ability, result orientation/solutions, personal efficiency, self-development, innovative and creative thinking, and leadership skills [15]. Based on the literature review, and adapted by the authors of this paper in Table 1. Skillset challenges in Industry 4.0 are presented.

Table 1. Project manager skillset challenges in industry 4.0 [2, 9]

Project management components	Skillset challenges for industry 4.0
Time management	• Real-time monitoring of project execution; • Eliminating gaps in progress reports
Cost management	• The foresight of the project cost and updating real-time cost progress indicators
Quality management	• Digitalization of project and automatic quality control of deliverables
Collaboration and teamwork	• Generalizing the use of virtual teams; • Using collective intelligence and building trust; • Building a collaborative environment; • Motivating and guiding the multicultural, delocalized, independent, and creative teams, and managing the relations among the other stakeholders with transparency and a sense of responsibility; • Developing authoritativeness instead of applying authority meaning the ability to create consensus, involving the team in the processes, be available to get involved, and demonstrate skills in valuing resources; • Applying gamification as a method in HR

(*continued*)

Table 1. (*continued*)

Project management components	Skillset challenges for industry 4.0
Communication management	• Accelerating and sharing communication processes within projects and with all stakeholders; • Increasing connectivity, shorten the time on progress reports, and the use of new ways of communication; • Active listening - using listening, capturing, and interpreting skills to consider impressions, opinions, moods, and outbursts from any stakeholder
Knowledge management	• Using and sharing of new knowledge to increase productivity; • Including both customers and suppliers in the collaboration
Project risk management	• Applying project execution simulation and using new techniques to identify and analyze risks
Procurement and resource management	• Sharing knowledge about purchases and the use of knowledge resources in project implementation; • Applying virtual platforms in procurement processes
Management of contingencies	• Increasing the speed of decision making and diligence in reacting to unexpected events
Learning from mistakes	• Observing the mistakes to build future successes instead of personal failure and frustration through the right strategy and proper way

4 Discussion and Conclusion

The remaining question stay, "What is the future role of project manager?". Will project managers have a different role or more precise meaning in the new age of business, or as some agile evangelist even wonder, will it become obsolete? [1].

This article aimed to explore not only the influence of Industry 4.0 on project management as a discipline but also to point out what are the skillset challenges imposed in this new era.

The literature review showed that there is almost an equal need for a project manager to have "hard" and soft skills to execute the project successfully in Industry 4.0.

Development of personal and soft skills in a modern high tech-based society plays a crucial role to accomplish business sustainability. "Hard" technical skills are not enough. Soft skills are critical, too, because they arise from the impact of demographic change, different social, cultural, political, religious, and economic values. According to new globalization trends, it is needed more than ever to possess extended and visionary views of managing, followed by a complex but united skillset.

Projects will continue to change in terms of scope and growing complexity, and project management will continue to involve an irreplaceable combination of skills, leadership, and ethical behavior. Required skills will vary depending on different impacts such as the shift of social values, demographic change and increase of virtual work, the complexity of processes, pressure for innovations, and ongoing globalization [16]. Possessing technical "hard" skills, transformation skills, and social skills, the future and current workforce will have the required qualifications and different approaches to the new challenging problems and situations [17].

The emerging of new demanded competencies and professional skills brings many challenges to find the right way and time to integrate and acquire these skills. Still, it is something that project managers and leaders of a new age will need to confront and overcome challenges imposed in the future. In this new global system, managing the change means the change of management as well.

Future research should cover more broadly this topic through a systematic literature review. Future empirical analysis should reveal the most important challanges that Industry 4.0 brought to project management and how it will impact the future development of the project management profession.

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Possible Application of Service-Oriented Architecture in Domain of Land Administration System

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Abstract. Service-oriented architecture refers to a software development paradigm in which individual components of the system are treated as services. This paper aimed to investigate the usage of service-oriented architecture in the land administration system. The possible advantages of this approach would be the ability to handle the system complexity by using multiple smaller components and the ability to use the appropriate programming languages, frameworks, and paradigms for each part of the system. In this paper, it is presented how a system, such as Land Administration System, can be (re)built based on service-oriented architecture, with concrete examples of its parts (layers). The goal of this paper is to represent the way how different systems, interacting with each other, can perform their tasks, such as adding a new parcel, all with the aim of failure-free functioning of these systems, with following analysis of the advantages and disadvantages of this approach. It is concluded that migrating Land Administration System to this type of architecture could provide a better performance of the whole system, since applying service-oriented architecture increases interoperability of land administration system and other systems with which it interacts.

Keywords: Service-Oriented Architecture · Web services · Land Administration System

1 Introduction

Service-Oriented Architecture (SOA) represents a software architectural style where services are provided to the other components by application components, through a communication protocol over a network. This architectural style uses services as its basic concept and Web services are one of services types.

SOA is different from the traditional architectures. It possesses unique architectural characteristics and regulations which have to be analyzed and defined. Also, it needs to apply the information that should be included in the architectural model of SOA correctly to service-based application development [1].

In a SOA, independent Web services can be available on a network. These services are available for the developers, who can create software solutions by combining SOA services [2].

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 496–502, 2022.
http://doi.org/10.1007/978-3-030-97947-8_65

Web services can be described as building blocks of SOA. They can include any software, application, or cloud technology that provides standardized Web protocols (http or https) to communicate, interoperate and exchange data through Internet. Web service is available through an interface that specifies the physical address. Consumption of a Web service represents the process of exchanging of data over the Web. New applications can be constructed through consuming these services and orchestrating them within a business process [1, 3].

Today, there are a few types of Web services. The most commonly used types are SOAP and REST. SOAP, which stands for Simple Object Access Protocol, is an Extensible Markup Language-based (XML-based) Web service protocol, used for exchanging data over HTTP or SMTP. SOAP allows independent processes, performing on different systems, to communicate using XML. REST stands for Representational State Transfer. REST represents an architectural style, in which data and functionalities are considered as resources and are accessed using Uniform Resource Identifiers (URIs), typically links on the Web. The resources are handled by using a set of simple and well-defined operations. A RESTful Web services also use HTTP protocol and offer HTTP methods such as GET, POST, PUT, DELETE and PATCH.

This paper aims to describe the possible design and implementation of SOA using the Web services in domain of Land Administration System (LAS).

LAS can be defined as data and information collections, processes and tools which are governmental responsibilities [4]. LAS has to identify and locate real properties. Also, it needs to register use, value and ownership of those properties. LAS can be realized either as a dual system, containing separate land book, which holds data about title holders on real property, and land cadastre (real property) or as a unified system with one register (Real estate cadastre) [5].

A country supervises and maintains LAS through public authorities. Also, it cooperates with the private sector which contributes as much as the regulation in certain countries allows such actions. Private sector usually does the work of individual access and occasional registration just for the purposes of data maintenance [6].

LAS can be divided on two registers: land register and cadastre. Land register represents an official record of rights on particular land. Land register should provide an answer on who owns a particular property and which legal document is a confirmation of that ownership. Cadastre can be described as a public repository of data regarding properties within a particular district or a country [7].

LAS aims to integrate the data of these two registers and ensure the consistency of the integrated data. Data within LAS can be divided in two groups. First group are data about ownership and other rights on real properties. This group is named as legal data. The other data group are data that represent objects, such as points, lines and polygons, defined in a geometric space. This group is named as spatial data.

Apart Introduction and Conclusion, this paper is organized as follows. In Sect. 2, a short review of related work on subject of SOA and LAS is given. In Sect. 3, an example of possible implementation of SOA in domain of LAS with following conceptual scheme is presented, with a review on desirable layers of architecture itself and their particular tasks.

2 Related Work

In 2015, Randall C. and Rankov A. had a brief disclose on a migrating a non-service-oriented API, such as a procedural or object-oriented API, to a service-oriented architecture. In this paper, primary and secondary concerns were identified. Primary concerns were grouped into services configured to address those concerns. Secondary concerns were addressed as context within which services addressing primary concerns are performed, such as profiles, filters, request parameters, etc. It has been concluded that in a content of management solution, primary concerns include core inbound and/or outbound operations, like adding content to a body of managed content, retrieving that content, searching for content, etc. Secondary concerns include how relationships between objects are handled, how complex objects, such as virtual documents are handled, how multiple exposures of content are handled and etc. [8].

In 2015, Malkis A. and Marmsoler D. published a conference paper. In this paper, they have provided an abstract model for the service-oriented architecture style. Their result offers a technology-independent characterization of the SOA style, which can be used by software architects. The goal is to ensure that a system is indeed built according to that style. They state that the results of style analysis apply to all systems built according to that style [9].

While all such references provide the SOA background for this paper, there are also couple of relevant references on topic of LAS.

For purpose of developing information systems for land administration, International Organization for Standardization (ISO) published ISO 19152:2012 Geographic information – Land Administration Domain Model (LADM) [10]. As it is stated, the given model is not a complete solution for any given country, instead it should be used as foundation, permitting extensions to facilitate country's special needs.

On the importance of having a quality LAS in one country, Dale P. and McLaughlin J. gave a brief indication. They state that even though collecting and maintaining data about land could be expensive processes, a good LAS has benefits that greatly outweigh its cost. The basic question is not whether countries can afford such a system, but can they afford not to have it [11].

Pržulj Đ., Radaković N., Sladić D., Radulović A. and Govedarica M. proposed domain model, in 2017, for solving problems that usually occur in the process of data integration of land registry and cadastral systems with land use component. As it is stated, proposed model could be a foundation for easier data inconsistency detection by applying database mechanisms, as well as the object-oriented applications for data integration [12].

In 2017, Sladić D., Govedarica M. and Radulović A. published a conference paper, which describes the state of cadastral data in Serbia and the software and data models used. Also, it analyses the user needs for cadastral data and the means of propagation through dedicated Web portal or via Web services [13].

In 2018, Stefanović M. et al. published a conference paper. It is stated that blockchain technology, more precisely smart contracts, could bring improvements to process of registering transactions in LAS [14].

3 SOA in Domain of LAS

There are a lot of possible functionalities that could be provided by LAS built based on SOA approach. For example, returning data about particular parcel, updating parcel, deleting or adding a new parcel to the system, are some of functionalities that could be combined with other features of the LAS to provide full-fledged system application. According to LADM [10], a parcel is an instance of class LA_Parcel. LA_Parcel is a subclass of class of LA_SpatialUnit. Therefore, class Parcel inherits the attributes of LA_SpatialUnit class. Attributes that one Parcel instance should have are:

- parcel_ID,
- address - the link to external address(es) of parcel,
- area - the parcel area value,
- dimension of parcel,
- label - presents a short description of the parcel,
- referencePoint - coordinates of a point inside the parcel,
- volume (in case of bounded 3D description) that represents the volume value [10].

The consumer application, for example some Web application, can use a service provided by the vendor or the network without human intervention. In simple terms, implementing of SOA means that software developer is developing a component or a service so some other user can connect to created service and make use of it. Let's suppose that LAS provides a service which contains a method that returns values of parcel properties, which are data of particular parcel. Format of returned data will depend on service type. For example, if SOA is implemented based on RESTful Web services, data of particular parcel can be returned in JavaScript Object Notation (JSON) format.

When it comes to implementing a SOA architecture, some key aspects should be considered and analyzed. In terms of LAS, service provider would be LAS itself. All the facilities functions will be provided as methods in this system. All of them can be published to the service broker. Service broker can be described as a registry of services. It stores information about what services are available and who may use them. Then, the service consumer, which can be some Web application communicating with a LAS, connects to a service provider through service broker. This way, consumer can directly communicate to the specific service. The LAS can define a set of functions or services and register them as a facilities which it has. For example, system can provide a service with function for adding a new parcel. The system has to return information to user if adding a new parcel to the system is approved or not. To do so, it is necessary for the user to provide his credentials when logging to the system. This way, LAS security mechanism can do the operations of authenticating (confirming user identity) and authorizing (deciding if identified user is allowed to access to the system and do particular operation). Generally, user who is identified as an administrator of the system, should have the access to all of the services that LAS provides and therefore, he should be able to manipulate with particular parcel.

However, the implementation of SOA through Web services in the domain of LAS does not have to be reflected exclusively in the provision of CRUD operations on particular database table. Web services can also perform some other operations, such as checking for inconsistencies and incorrectness of data obtained by LAS. Usage of Web services can be provided in processes of checking geometry and topology correctness of spatial data included in LAS.

Stefanović M. defined cadastral data incorrectness as a case in which data about area calculated from polygon shape that represents parcel in cadastre are not correct [5].

For example, it is possible that some parcel contains four parts: part with building (a) and part (d), both presenting some non-agricultural fields, and parts (b) and (c) which present agricultural parts of that particular parcel. Each part of parcel is instance of LA_SubParcel class, which is, according to LADM [10], a subclass of previously mentioned class LA_SpatialUnit. Therefore, each sub-parcel (part) inherits attributes from LA_SpatialUnit class. One of those attributes is area. Now, let's suppose that recorded value of parcel area is 2000 m^2. However, a situation is possible, in which a sum of sub-parcel areas exceeds parcel area (2000 m^2). For instance, an area of: sub-parcel (a) is 600 m^2, (b) is 700 m^2, (c) is 700 m^2 and (d) is 200 m^2. A sum of these area values (2200 m^2) exceeds parcel area by 200 m^2. To address this kind of incorrectness issue, a Web service can be implemented. This Web service would have to preform the operation of data integrity check, in terms of parcel and sub-parcels area values evaluation, and inform the consumer application about issue that exists.

Also, a case that causes a cadastral data inconsistency may occur. Let's suppose that a building of sub-parcel (a) is positioned outside of the boundaries of parcel that it belongs to. Such a case leads to a disruption of topological relations. To address this kind of problem, an appropriate Web service could be developed and implemented, so it can ensure that topological relations between two parcels and their sub-parcels are not violated. This way a chance could be reduced or even eliminated that, during the processes of adding and integration of data in LAS, violated topological relations are occurred.

3.1 Applying SOA RA Layers

Accomplishing any service requirement can be achieved with capabilities of combining one or more layers in the SOA Reference Architecture (SOA RA). Each service can have a contract and functional element. The service contract element or service interface defines what the service does for the consumer of a service. The functional element implements what a service has to provide based on the service contract element or a service interface. "The service contract is integrated with the underlying functional element through a component which provides a binding. This model addresses services exposing capabilities implemented through legacy assets, new assets, services composed from other services, or infrastructure services" [15, 16].

The possible interaction flow between implemented layers is presented on Fig. 1.

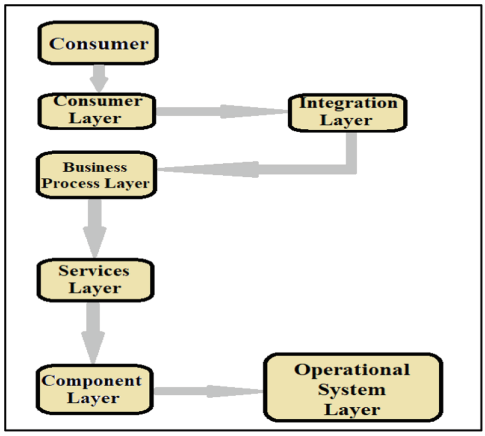

Fig. 1. Layers in SOA RA and interaction among them

Service consumer can request services using the integration layer. The integration layer can invoke the particular service request. This request can be a certain type of business process contained in the business process layer. In terms of LAS, business process represents any type of operation that leads to changing or reading data contained in database of this system. Business process layer is using one or even more services, which leads to invoking the services layer. The services layer can then bind and invoke service components in the service component layer. Service components in the component layer invoke solution components from the operational systems layer to execute the service request. As a result, the response is sent back to the service consumer.

4 Conclusion

The ability of services to be successfully run on different servers within an environment can increase their availability and scalability. In terms of LAS, SOA can be designed so that each change can be done successfully. By implementing SOA, LAS business processes can be performed smoothly, and services can be reusable and reconfigurable. This means that the service can be re-used many times in different consumer applications. Reusability of the services can lead to increased productivity in terms of evolving existing services, since developers can use the concepts on previous services, by not creating each application from the scratch. Reconfiguring means that if particular service needs to be updated or changed, instead of starting completely from scratch, SOA developers are able to configure the way the service is deployed. Within this paper, examples of problems where Web services can play an important role during solving those problems, are presented. It can be concluded that appropriate Web services can be developed for the entire domain model, and that they could provide different controls and business logic. Since SOA services are self-contained programs, they can be more easily tested, debugged and maintained. It is concluded that possible application of this architecture type in domain of LAS could provide a better performance of the whole system, since it increases interoperability of LAS and other systems with which it interacts.

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Evaluation of Impacts on Worker from Fixture Production with Life Cycle Assessment

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Abstract. Life Cycle Assessment (LCA) is standardised and well known method for evaluation of environmental impacts through the products life cycle. In last two decades LCA methodology framework has been used for evaluation of other life cycle aspects such as costs, social, organisational and working environment impacts. Working environment LCA evaluates impacts that occur in the product or process life cycle on worker. Impacts on worker are usually expressed through the impact category such as: fatal accidents, total number of accidents, central nervous system function disorder, hearing damages, cancer, musculoskeletal disorders, airway diseases (allergic and non-allergic), skin diseases, psycho-social diseases, disability-adjusted life years units, and other. This research evaluates the impacts on worker during the production of fixtures. Fixtures are a very important part in production engineering as they are used to secure the workpiece in steady and stable state during the various manufacturing operations. Obtained results confirm the previously research in field of fixture production LCA, that consumption of steel generates dominant impact on environment and worker. Furthermore, results show how the environmental impacts and impacts on worker are mutually related through the fixture production operations.

Keywords: Life cycle assessment · Working environment · Fixture

1 Introduction

Although the environmental life cycle assessment (LCA) is well known, the social LCA and LCA in field of safety at work are starting to gain their momentum in scientific community. Besides the main purpose to assess social impacts, social LCA is developed to accompany environmental LCA and life cycle costing. The three LCAs provide a comprehensive analysis, namely sustainable LCA, where environmental, economy, and social aspects are analyzed through the products and processes life cycle. Within the social LCA [1], impact on workers' health and safety during the life cycle is a group of stakeholder impact categories that can provide information on accident rates at workplace (non-fatal and fatal), occurrence of various diseases and injuries, disability-adjusted life years (DALY), presence of safety measures, etc. Arvidsson et al. [2] presented a method based on DALY for assessing human health impacts within social LCA.

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 503–509, 2022.
http://doi.org/10.1007/978-3-030-97947-8_66

Working environment LCA (WE-LCA) [3] aim to compile and evaluate potential working environmental impacts on humans of a product system throughout its life cycle. Furthermore, damage to human health attributable to the work environment can be assessed as DALYs [4]. Authors in [5] developed an approach to account for occupational exposure to chemicals by inhalation in LCA. They combined labor statistics and measured occupational concentrations of chemicals from the OSHA database to calculate operational life cycle impact assessment (LCIA) characterization factors. Kim and Hur [6] research aimed to integrate both the working environment and the external environment into the conventional LCA framework. In their research, for the impact category indicators at the endpoint level, LWD (Lost Work Days) was employed to evaluate the damage to human health and safety in the working environment, while DALY and PAF (Potentially Affected Fraction) were selected to evaluate the damage to human health and eco-system quality in the external environment, respectively.

In this paper authors further investigated the life cycle impacts of four fixture structures previously analyzed in [7]. This research analyzes the impacts on workers of four fixture structures with WE-LCA methodology [3] that evaluates potential number of accidents and diseases through ten impact categories.

2 Materials and Methods

The goal of the LCA is to evaluate the impacts of four fixture structures (F1, F2, F3, and F4) on worker in manufacturing life cycle phase. Fixtures are used in manufacturing systems to assure that the workpiece is firmly secured in place during the various production operations. Considering that various fixture designs can be applied for the same workpiece, four fixture structures have been evaluated in this research. Therefore, the system boundaries include processes of material and energy use during the production of fixture (Fig. 1).

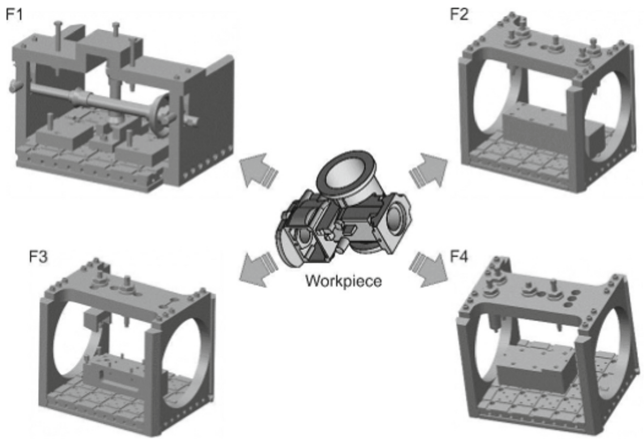

Fig. 1. Workpiece and fixtures F1–4 [7]

Life cycle inventory (LCI) data from previous study [7] was used for four fixture structures. Only the mass of the steel of finished fixtures structures has been taken into account for LCI. The LCI, the mass of the steel in fixture structures, is presented in Table 1.

Table 1. Life cycle inventory for four fixture types [7]

Material	Unit	Fixture structure			
		F1	F2	F3	F4
Steel	kg	260.50	323.50	297.20	310.20

Because the goal of this study is to evaluate impacts on worker, specific LCI database and LCIA methodology had to be applied. For LCIA, the methodology for evaluation of working environmental aspects in LCA developed by Schmidt et al. [3] was selected. WE-LCA methodology is based on EDIP LCIA method. LCIA considers two types of Danish statistical information regarding economic sectors, i.e. information on the amounts being produced (in weight units) in a number of sectors, and information on the number of reported work-related diseases and damages in the same sectors [3]. The following impact categories are included in the assessment of the working environment: fatal accidents, total number of accidents, CNS function disorder, hearing damages, cancer, muscolo-sceletal disorders, airway diseases (allergic), airway diseases (non-allergic), skin diseases, psycho-social diseases. WE-LCA methodology calculates the impact on worker by multiplying the quantity of the inventory flow with the corresponding characterization factor for each impact category:

$$Working\ environment\ impact = inventory\ quantity \times characterization\ factor \quad (1)$$

The characterization factors for the LCIA are provided in WE-LCA database [3]. The LCI database for WE-LCA covers about 80 economic sectors that are divided into four groups, i.e. raw material production (e.g. energy resources, metals, paper, etc.), production of intermediates and components (e.g. wood products, plastics, ceramics, metal products, etc.), production of final products (e.g. furniture and various electromechanical products) and transportation. The characterization factors for metal structures that were used for LCIA in this study are provided in Table 2.

In the WE-LCA methodology, the basis for the normalisation is the total number of reported working environmental accidents and damages in Denmark, distributed evenly on the number of Danes in the same period of time. Normalisation factors, annualy number of accidents per hundred persons, are provided in Table 2, while the normalised impact on worker is calculated as:

$$Normalised\ impact = \frac{Working\ environment\ impact}{normalisation\ factor} \quad (2)$$

Table 2. Characterization and normalisation factors [3]

Impact categories	Characterization factors for metal structures (Accidents and reported diseases per tons product)	Normalisation factors for Danish population (person equivalents)
Fatal accidents	1.80E–06	1.54E–05
Accidents	1.50E–03	9.69E–03
Cancer	8.80E–07	3.54E–05
Psicho-social damages	4.40E–06	1.40E–04
CNS function disorder	8.80E–07	6.37E–05
Hearing damages	6.30E–05	4.56E–04
Airway diseases (non-allergic)	1.30E–05	1.00E–04
Airway diseases (allergic)	7.00E–06	7.93E–05
Skin diseases	1.50E–05	3.12E–04
Muscolo-sceletal diseases	8.50E–05	1.44E–03

3 Results and Discussion

The results for LCIA of four fixture structures are shown in Figs. 2, 3, and 4.

In Fig. 2, impacts on worker are shown separately for each impact category. Impact categories have different range so the results are shown in bars that are expressed in percentages. Impact category for accidents shows largest results when compared to other. The distribution of impact is almost the same for all impact categories.

Normalised results shown in Fig. 3, can show the magnitude between the impact categories in person equivalent units. The total number of accidents, hearing damages, and non-allergic airway diseases have the largest impact on worker. On the other side, cancer, psicho-social damages and CNS function disorder are rare diseases that are attributed to fixture production.

In Fig. 4, beside the impact on worker, fixture mass and environmental impact have been added to show the relationship between these aspects. Figure 4 shows high correlation between the fixture (steel) mass, total environmental impact (normalised LCA results from previous study [7]), and impact on worker. These results show that the fixture mass is directly proportional to the environmental impacts and impacts on worker.

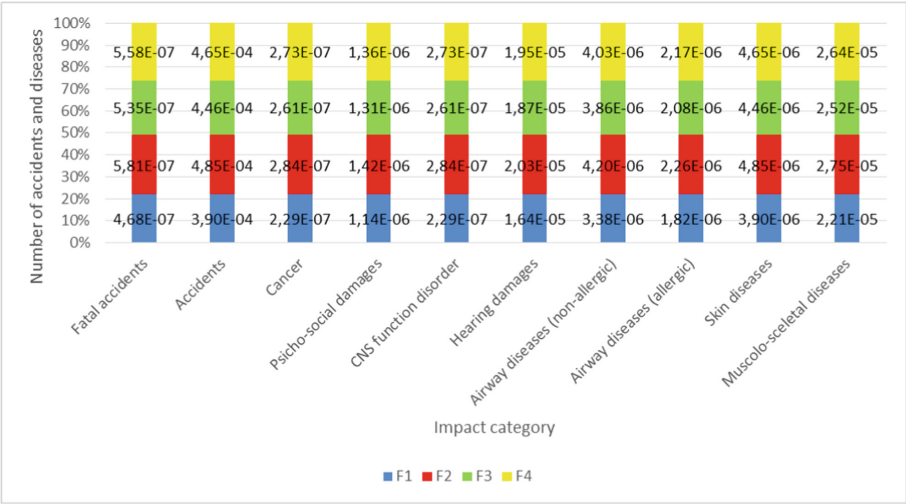

Fig. 2. Impact on worker

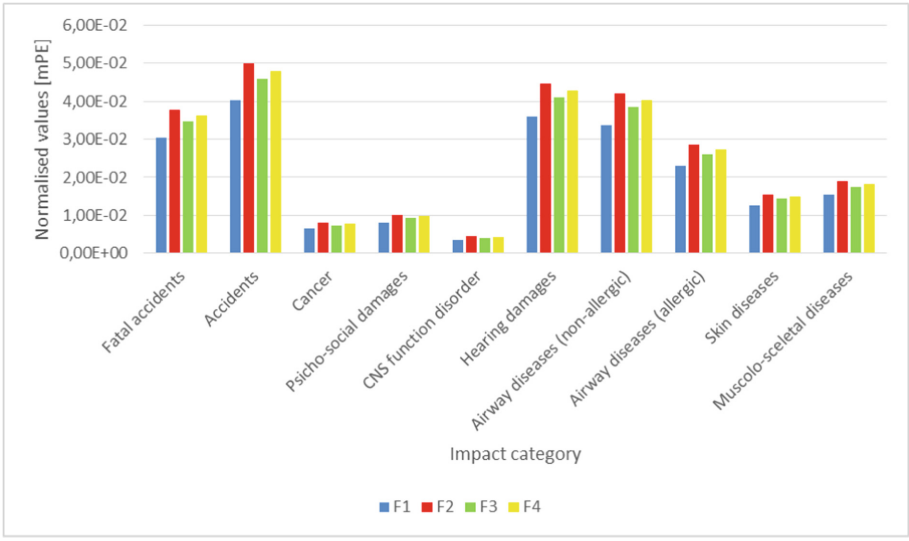

Fig. 3. Impact on worker in person equivalent units (normalised values)

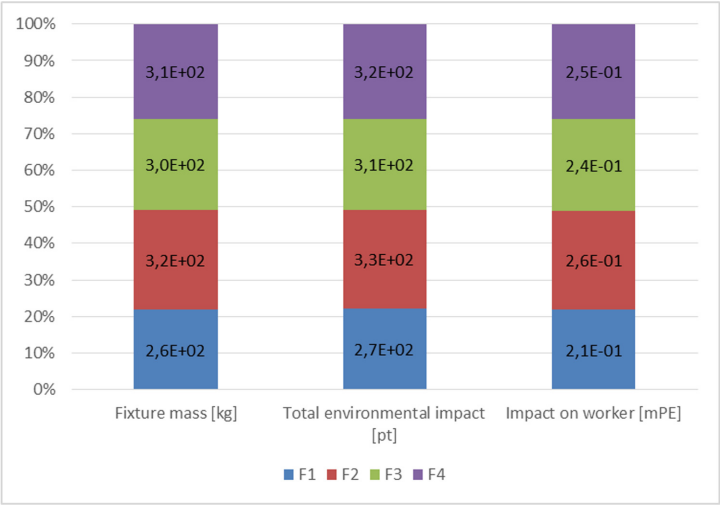

Fig. 4. Distribution of fixture mass, total environmental impact, and impact on worker.

4 Conclusion

The results from this research show that the fixture structure F1 has the smallest impact on worker, while on the other side, fixture structure F2 has the largest impact on workers. These results are directly proportional to fixture mass and environmental impact.

Regarding the WE-LCA method and its LCI database, the following conclusions can be made:

- The results could be significantly different if different geography data were used;
- LCI database for WE-LCA is outdated and considers Danish data only;
- LCI database for WE-LCA has very limited number of processes (activities). For example, new 3.6 Ecoinvent LCI database has more than ten thousand activities, LCI database for WE-LCA has only eighty. For example, specific processes for steel machining operations such as turning, drilling, milling grinding and other, that are important for LCA of fixtures can't be not found;
- Large uncertainty of results can be attributed to processes from the LCI database for WE-LCA.

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Fake News Detection on Social Networks – a Brief Overview of Methods and Approaches

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Abstract. Fake news spread around the internet has become a significant issue in recent years that attracts a lot of attention from both researchers and the general public. The major problem is that misinformation and propaganda which are proliferating across the digital landscape can greatly shape public opinion on many on-going topics, potentially having a significant political and social impact. Social networks are particularly well-suited for the distribution of made-up content by the usage of specialized software tools and artificial user accounts. Considering this, automatic fake news detection has become a primary goal of researchers in this field, which should help minimize the spread of misinformation by accurately flagging potentially problematic digital material. Yet, many challenges to effective fake news detection remain as there are not many indicators that can reliably distinguish fabricated content from the genuine one. This paper provides an overview of recent efforts in the field and summarizes contemporary approaches to devising classification models for fake news detection.

Keywords: Fake news detection · Social media mining

1 Introduction

In the last decade, on-line social networks have become the primary platform for sharing all forms and kinds of digital content, as they allow rapid information dissemination and have a huge user base. Over 62% of the American population receives their daily information primarily from social networks [1], meaning that the content being served can significantly shape their attitude and position regarding different topics. The same is true for a lot of countries throughout the world. However, not all content that is being distributed is genuine and can often be manipulated in different ways to achieve sometimes hidden goals on the agenda behind the entities sharing it. The usage of manufactured content in combination with user profiling and targeting has already been successfully used for creating desirable public opinion in the political domain [2], as well as in the corporate world to either boost a brand's reputation or to inflict damage to the competition [3]. The latter can be particularly effective in the era of modern

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 510–517, 2022.
http://doi.org/10.1007/978-3-030-97947-8_67

communications, as companies often rely on social networks as the primary means of communication with their customer base [4].

Hence, combating purposely manufactured content on social media has become the highest priority for researchers, governments and organizations worldwide, with a particular focus on the so-called "fake news", which according to some authors represents a deliberate presentation of (typically) false or misleading claims as news, where these are misleading by design.

In this paper, different approaches for automatic classification of content circulating social networks are reviewed, all of which have the ultimate goal of reducing the negative impact of fake news on the community. They often rely on a machine and deep learning techniques which allows them to constantly evolve and adapt to new kinds of fabricated content, as well as to scale up to deal efficiently with the enormous amount of data that they need to process.

2 Related Work

2.1 Fabricated Content Categorization

Considering the sheer amount of content circulating the Internet, it is very difficult to separate the fabricated content from that which is not. Hence, the very first step in combating manufactured content is to come up with a classification schema that would allow identification of its various sub-types. This is particularly important because the content comes in various forms such as videos, images, blog posts, website articles, direct textual messages, e-mail, etc. Meel and Vishwakarma propose a classification model for fabricated content that can be applied regardless of the content form. The model is adapted from [5] and presented in Fig. 1, where common features between distinct categories are represented as intersections in the Venn diagram.

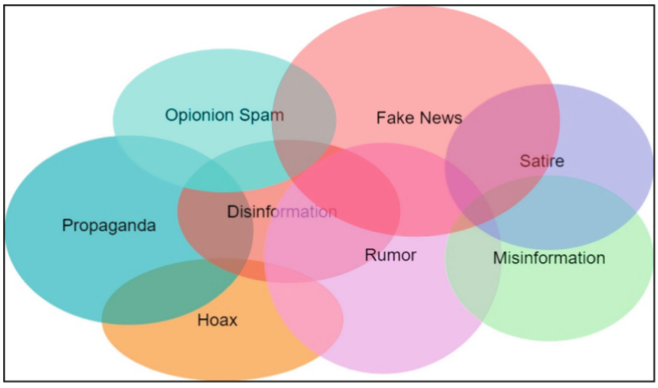

Fig. 1. Venn diagram of false information on social media and web, as proposed by [5].

Rubin proposes a similar model in [6] where he identifies three basic groups of fabricated content centering on fake news. According to him, fake news is most often

found on the Internet in the form of satire, hoaxes, and serious fabrications. Although this categorization is closely related to the one shown in Fig. 1, it relates fake news to hoaxes in the way that they both provide inaccurate information through social networks with the intention of being adopted by traditional sites with real news.

Other authors offer an alternative classification of fabricated content [7, 8]. In their models, it can appear in the form of misinformation, rumors, fraud, spam, fake news, or even a malicious trend. The common definition by which these terms could be linked is that it is unverified information, which is easily spread on the Internet to manipulate the reader's opinion or blocking his knowledge of certain topics. This makes a firm and unambiguous definition of "fake news" somewhat elusive and although previously mentioned categories can be observed as distinct groups within different contexts, they are often used interchangeably.

2.2 Fake News Cycle and Interactions

To successfully combat the spread of fake news on social networks, it is necessary to identify the key elements and actors involved in the process as well as the relationships between them. Most commonly, researchers identify three key factors that influence the speed of spread and reach of fake news: the publisher, the content, and end-users (consumers).

Publisher represents the source of the message, the creator of the content and the initial point in the chain of fake news distribution. Even though the publisher is often thought of as a person, it can also be a piece of software designed to automatically execute tasks on social networks simulating human behavior (also known as a bot), or an entire organization with substantial resources at their disposal. Also, it is important to note that the publisher does not necessarily have to be the original author of the story.

Content is the essence of news that is being transmitted through various publications. In addition to the core information most commonly conveyed via textual content, news often contains additional multimedia content such as images, videos, or audio clips. Such media can often conflict with the textual content of the news and its purpose is to cause the user to click that news to access its content (also known as "click-baits").

Users, who represent human actors or bots that do most of the content distribution. Their interconnectedness and behavior on social networks can often be a very good indicator of the kind of content they primarily share, as research has shown that it is possible to calculate the credibility score for each user (the quality of being trustworthy) based on their social media activities and use it to help determine whether they are more likely to share true news stories or not [9].

The relationships between these three core elements are illustrated in Fig. 2. The edge ($p \rightarrow a$) shows that publisher p publishes news item a, an edge ($a \rightarrow u$) represents that item a is spread by user u, and an edge ($u1 \leftrightarrow u3$) represents the social relation between user $u1$ and $u2$. These relationships can be leveraged to effectively identify fake news as demonstrated by Shu et al. in [9], where they exploit the social context of the content by simultaneously modeling publisher-news relations and user-news interactions via tri-relationship embedding model to significantly improve fake news detection over selected baseline models.

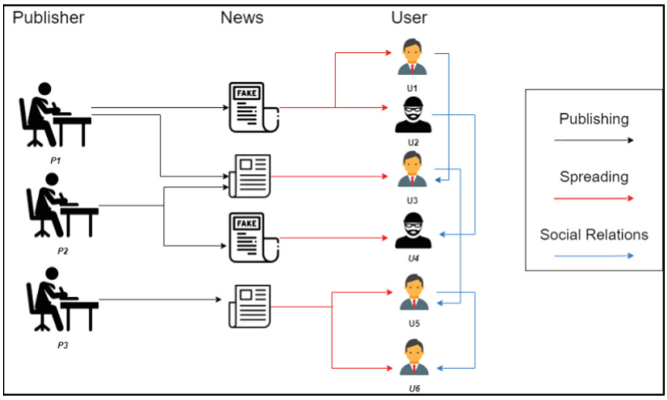

Fig. 2. An illustration of tri-relationship model as proposed in [9] (adapted)

The notion that social context plays a significant role in designing approaches for identifying fake news is further strengthened by [10], who show that users tend to form stronger links with people who have similar interests and are more likely to re-share the content coming from thinkers-alike without critically analyzing its veracity.

2.3 Content and User-Based Features for Fake News Detection

Besides focusing on the social context of the content being shared, researchers have also analyzed the possibilities of using content-specific and user-specific information as features for classifying on-line social media publications as real or fake.

In a study conducted by Tacchini et al. [11], a quite efficient classification model for categorizing posts into hoax and non-hoax types was proposed, that leverages user interactions with the content (i.e. likes) as the primary source of information for constructing input features. They gathered a set of 15,500 Facebook posts stemming from two categories of Facebook pages (one representing pages known to publish reliable scientific material and the other publishing mostly conspiracies and hoaxes), which were interacted with by a total of over 900,000 users. By observing only which users liked which posts (represented as a sparse matrix where users represented columns, posts represented rows and interactions between the two were labeled as zero or one) and using the category Facebook page publishing the post was assigned to as a target label, the authors were able to create binary classifiers that exceeded 99% accuracy when doing 5-fold cross-validation. Besides, they were able to achieve high levels of accuracy even when using only a fraction of the data for training the models, suggesting that the approach might be feasible even in cases where scaling-up (in terms of data volume) is a major concern.

Attempts to assess the personalities of users who exhibit different behavior with regards to interacting and spreading fake or genuine news is explored in [12]. In this research, authors leverage interactions of users with content designated as real or fake (based on the source and verification status of the content by expert journalists) to classify them as susceptible to fake news or not. Then they proceed to compare inferred personalities of each distinct group by using the Five-Factor Model to characterize each user

in terms of Extraversion, Agreeableness, Conscientiousness, Neuroticism and Openness dimensions. To obtain scores in each dimension they use a pre-trained state-of-the-art unsupervised text-based personality prediction model. The results of the study indicate that both groups exhibit relatively high Extraversion and Openness, and relatively low Neuroticism scores, indicating more outgoing and intellectual personae. However, the observed differences between the groups indicate that users who are more extroverted and friendly are also more likely to trust real news. When comparing explicit features such as tenure (time since the user account was opened) and whether the account has been verified on platforms where users interact with the content or not, the study has shown that older accounts tend to be more trusting towards fake news while more recent accounts tend to spread more real news.

Just like user characteristics, the style of writing used for produced content can be used to make a distinction between fake and real news. In an experiment conducted by Perez-Rosas et al. in [13], it was shown that there are sometimes significant differences in the style of writing between the fake news texts and those that are not. The authors created two novel fake news data sets covering seven different domains by using legitimate news articles as a foundation for creating plausible-looking fake news articles. To this end, they used crowdsourcing (Amazon Mechanical Turk) and manual efforts to make the fake content as realistic as possible. They then leveraged a combination of lexical, syntactic, and semantic information as well as the one pertinent to text readability properties to construct features to be used by classifiers to obtain models for the fake news classification. Based on these linguistic differences in the text, best-performing models were able to reach the accuracy of up to 78% which is comparable to human performance in some domains.

2.4 Modelling Approaches in Fake News Detection

The recent rise in popularity of deep learning approaches to solving real-world problems owes much to the fact that artificial neural networks are often able to outperform traditional machine learning algorithms and statistical modeling techniques, due to the sharp increase in the amount of available data necessary to train them and technological advances that made specialized hardware (such as GPU's or FPGA's) affordable. The upside of artificial neural network (ANN) approaches is that they can automatically extract useful features from the training data and use them to come up with a good approximation of the complex mapping function that translates them into a target variable, while the downside is that they represent so-called "black-box" models – meaning that it is very difficult for humans to interpret and understand their inner workings, which is sometimes very desirable or even necessary. Similar can be said for some of the machine learning algorithms as well.

One of the experiments that make the comparison between ANN approaches and machine learning/statistical modeling ones for classifying fake news is the one conducted by Lin et al. in [14]. The authors compare seven different models obtained by using different binary classifiers in terms of accuracy, precision, recall and the F1 measure. In particular, they compare Logistic Regression, Support Vector Machines, K-Nearest Neighbors, Random Forest, AdaBoost, XGBoost and a recurrent neural network (Long Short Term Memory with self-attention mechanism). The features they use

represent a set of 134 hand-crafted attributes pertinent to the textual content of the articles obtained (and classified either as being true news or fake news). Results indicate that in this particular task ANN does not have an edge over traditional approaches such as Logistic Regression, K-Nearest Neighbors or Random Forest, and even lags behind the best-performing XGBoost model that managed to achieve over 85% accuracy after hyperparameters tuning.

On the other hand, a case where ANN approach demonstrated superiority over simpler classifiers (i.e. Logistic Regression) is described in the work of Jin et al. [15], where the authors use Recurrent Neural Network with an attention mechanism to fuse multimodal features (derived from textual and social context as well as visual content) to obtain a powerful classifier for rumor detection in multimedia datasets collected from Weibo and Twitter. Compared to logistic classifiers trained separately on each set of multimodal features, the proposed ANN approach was able to achieve over 13% higher accuracy in detecting fake content (i.e. rumors).

Speaking of approaches that aim to combine information from multiple perspectives while devising a classifier, a study conducted by Ruchansky et al. in [16], aims to first separately assign scores to content obtained from Weibo and Twitter based on its textual and temporal features (the latter being user engagements and reactions) and merge them with the credibility of users (calculated based on their interaction with fake content) to obtain final labels for each content item ultimately designating it fake or real. The resulting model, dubbed CSI (Capture-Score-Integrate), shows better performance than competing ones by exhibiting 89% and 95% accuracy on Twitter and Weibo sets respectively. Research in [17] in a way extends the efforts presented in [15] and addresses a concern that multi-modal feature representations are still highly dependent on specific events in the dataset, and are not able to generalize well to identify fake news on new events. They proposed an approach relying on three components (namely multi-modal feature extractor, fake news detector and event discriminator) to learn the event-invariant representations of content by removing the event-specific features and subsequently create a model based on adversarial neural networks that was able to outperform previous models.

Finally, authors in [18] introduce a novel data set for fake news detection that is an order of magnitude larger than the previously available ones and propose a hybrid convolutional neural network that integrates content's meta-data with its main textual data to demonstrate its superiority over text-only based approaches.

3 Discussion and Conclusion

One of the major problems in using user-centric data in detecting fake news content on social networks is that the potentially most valuable information (such as demographics, affiliations with different entities or information on person's social network circle) is often impossible to access or simply does not exist (if the platform doesn't require it). Hence, even though it can be seen from the studies reviewed in this paper that users are usually key elements of devised predictive models, such potentially informative features on them must most often be indirectly derived. In addition, even the 'ground-truth' labels sometimes assigned to users such as "high credibility" or "low credibility" are derived

indirectly from their interaction with the content that has been previously identified as "true" or "fake". This might introduce some bias into the predictive models, the effect of which should most likely be studied to avoid potentially unwanted consequences when they are used in real-world settings (such as censoring the real news after it was mistakenly flagged as fake).

It is also apparent that more complex approaches to fake news detection which try to incorporate multimodal or multi-view information usually exhibit better performance than unimodal or single-view ones. This warrants further investigation into the ways of extracting additional features from the existing data, which might be the result of combining content from different sources or coming up with novel perspectives on the content or user interactions. For example, even though raw visual media in the content (such as images) is often leveraged to automatically extract features which appear to help classification accuracy of the overall content, it might be interesting to see whether and how the actual interpretation of the visual content (i.e. object or activity recognition and classification, underlying semantics and connection with the textual content) might affect the final classification (as it was shown, for example, that user perception of different potential metrics of interest such as video quality can be affected by the content of the video itself [19]).

In terms of algorithms and modeling techniques used to come up with predictive models, it appears that ANN-based approaches are dominating this research area, just like many others.

Future research in this field and progress in the development of false news detection mechanisms can contribute to improving the credibility of real news sources, which would increase people's trust in these sources of information and drastically reduce the creation of misconceptions that could have positive social and political impacts.

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Multimodal Techniques and Methods in Affective Computing – A Brief Overview

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Abstract. In the domain of affective computing, observation and analysis of facial expressions are predominantly used to detect how people feel at a particular moment. However, recent research has shown that this approach leaves much to be desired, since facial expressions alone do not seem to be directly translatable into different emotions. For example, if people are smiling, it does not necessarily mean that they are happy. Hence, to increase the accuracy of emotion recognition, there is a need to take into account additional signals such as those stemming from human behaviour (e.g. pose estimation), spoken content (voice analysis and natural language processing), environmental context, as well as various physiological signals. Approaches that aim to process information received from multiple sources simultaneously are called multimodal, and this paper provides an overview of current efforts in this area of affective computing. Advantages of distinct approaches are analyzed, and their performance in terms of accuracy is assessed. Discussion summarizes the findings and outlines the most promising future research directions.

Keywords: Affective computing · Multimodal analysis · Emotion recognition

1 Introduction

Affective computing is a scientific area that combines computer science and engineering disciplines with those in social and medical domains (such as psychology, sociology, physiology, neuroscience, etc.) with the goal to recognize emotional signs during a person's interaction with a computer and form an emotional response [1]. This relatively new area is witnessing a substantial increase in interest from both the academic community and industry practitioners alike. While the former is often more interested in complex phenomena observable during human-machine interaction, the latter have realized that many scientific findings in this field have a wide practical application and can be used to achieve different business goals. For example, the retail industry has long since discovered that social networks represent an invaluable trove of information on their customers and affective computing offers novel ways to tap into it by providing additional insights into their attitudes and opinions towards particular brands, services, products or other entities of interest. By analyzing comments, reviews, ratings and other

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 518–525, 2022.
http://doi.org/10.1007/978-3-030-97947-8_68

forms of communication on social networks, companies are able to identify not only topics and trends in the examined content, but also to pinpoint potential customers who are most likely to be interested in a particular product and thus substantially reduce marketing expenses [2].

The variety and sheer amount of online content being created and shared nowadays in forms of visual (images, videos), audio (podcasts, music, etc.) or purely textual data make extracting emotional information embedded in it quite challenging. Therefore it should not come as a surprise that a lot of research effort is currently being invested in devising automated approaches to detecting emotional cues and applying labels to identified emotional states in diverse content. Two very active areas in this domain are sentiment analysis and emotion recognition, which jointly describe affect [3]. Sentiment analysis generally has a goal of identifying the affective state a person is in and labelling it with one of the mutually exclusive classes (usually: positive, negative, or neutral), while emotion recognition focuses on detecting more complex and diverse emotional categories such as surprise, joy, disgust and anger [4] as well as their apparent relative presence in the content observed.

Given the success of machine learning and AI-based (Artificial Intelligence) models in solving Computer Vision, Audio and Natural Language Processing problems, they are often the go-to tools of researchers when making inference on sentiments and emotions in data coming from the respective modalities (i.e. visual, audio and text). Sometimes the data can come in the form of sensory readings as well (such as blood flow, heart rate and brain activity measurements) but this modality is not as frequently used as the three aforementioned ones for emotion detection outside specific use-cases. Information obtained from different modalities is often combined using fusion techniques that aim to produce synergistic effects by exploiting contexts of observed cues in distinct modalities to enrich the others and finally produce more accurate results and predictions. In this paper, we present a brief review of such multimodal techniques in affective computing.

The rest of the paper is organized as follows: in Sect. 2, different kinds of features that are commonly extracted from distinct modalities when doing sentiment analysis and emotion recognition are explored, Sect. 3 provides an overview of contemporary multimodal fusion approaches and their reported performance on benchmark datasets while Sect. 4 provides concluding remarks.

2 Sentiment Analysis and Emotion Recognition Features

Sentiment analysis and emotion recognition are quite often employed in the field of natural language processing, where additional challenges must be faced first in order to arrive at a final label for the observed content. These include word polarity disambiguation (e.g. dealing with negation), concept extraction, subjectivity detection, personality recognition and aspect extraction [5]. In the NLP domain, there are two groups of techniques commonly employed to classify the sentiment and perceived emotions expressed in the observed content: ones that rely on machine-learning and the others that are lexicon-based [6]. The former utilize machine (and more recently deep-) learning approaches to approximate complex functions that map input features to the target concept that is being learned (i.e. sentiment or emotion label), while the latter relies on the semantics

of particular words and phrases in different contexts. Considering that user-created content, which is frequently the subject of the analysis, is often informal, indistinct and evolves over time, these factors can lead to misinterpretation of the language and poor performance of predictive models. This was recognized by researchers in the field who have tried to combat such issues by mapping the known phrases, abbreviations, hashtags and emotion-conveying string combinations (such as emoticons or the repetition of a particular letter at the end of the word) to their perceived sentiment or emotion [7] and use those mappings as features in creating predictive models [8]. Furthermore, textual content under scrutiny is rarely suitable for summarization via a single label; more often than not it encompasses distinct concepts each of which may have a sentiment polarity or an emotion expression of their own. This is especially pronounced in aspect-oriented sentiment analysis which assumes that polarity towards a particular entity is related to its specific aspects or its characteristics [9]. For example, if the user's opinion of a mobile phone is assessed, the quality of the photo the camera can make and the battery life are different aspects of it which might have distinct sentiment labels which are sometimes difficult to reconcile in one final label.

In the visual domain, human facial features are prominently used for sentiment analysis and emotion recognition. In the case of images, those are facial expressions (i.e. distinct position configurations of muscles beneath the skin of the face which humans describe as a smile, a frown etc.) which are mapped to different sentiment polarities and emotions, while in the case of video material they are used in conjunction with the temporal component – such as muscle movement over adjacent video frames (i.e. expression changes). Likewise, human pose estimation and changes in them (head position and gestures, such as head tilt or nodding [10], or body/limbs position and motion such as raised arms or crossing legs) are also commonly derived from visual content to add context to the observed facial features, as they can help interpret and sometimes even alter the perceived sentiment or emotion significantly. Since the majority of expressions of human emotional states are thought to be observable directly via visual and audio content [11], this modality is also one of the most frequently utilized to detect emotions and sentiment if available in the data.

Finally, audio-based sentiment analysis and emotion recognition rely on the acoustic features extracted from speech, such as pitch (or fundamental frequency), log energy, zero-crossing rate, spectral features, voice quality and jitter [12]. The content used to extract these features often comes in the standalone form (such as phone call logs, audio blogs, audio-books etc.) but is just as equally extracted from the videos in which it is usually embedded.

Regardless of the data modality (or combination of) being used by different approaches for sentiment analysis and emotion recognition, there is one key factor that can ultimately make or break derived models (in terms of their real-world usability) – which is the choice of encoding for the target labels (i.e. sentiments or emotions that are being predicted or recognized). Psychologists commonly refer to two distinct methods for modelling emotions. The first method relies on the notion that emotions (or emotional categories) can be expressed by a set of distinct basic emotions (or emotional labels) such as happiness, sadness, fear, anger, disgust and surprise, which can further be extended to derive more complex representations such as fatigue, anxiety, satisfaction, confusion

and frustration. However, the number and nuances often vary between sources, and there is no definitive agreement in academic circles when it comes to this classification. On the other hand, owing to its discrete nature, this schema is particularly useful in practical applications and is often used by practitioners in the affective computing domain. The second method is based on a multidimensional theory that categorizes emotions into multiple dimensions or scales where every emotional state can be expressed as a point in multidimensional space, such as the two-dimensional representation using arousal and valence or the three-dimensional one that adds the attention-rejection dimension to it [1].

3 Multimodal Fusion

Multimodal fusion is the process of integrating information obtained from different modalities to achieve a better performance of the devised models. As the amount of content that comprises multiple modalities (e.g. online video sharing services and different social networks) has been rapidly increasing recently, this led to the birth of numerous techniques to extract and exploit the information available in one modality to complement and augment features devised from the others. There are different fusion techniques that are applied to multimodal data, some of which are: feature-level or early fusion, decision-level or late fusion, hybrid multimodal fusion, model level fusion, rule-based fusion, classification-based fusion and estimation-based fusion. Their application and performance are described next.

To illustrate the necessity of using multimodal fusion in sentiment analysis and emotion recognition, the study performed by Schmidt et al. [13] can serve as a good example. In it, the authors created sentiment classification models by using audio-only (i.e. audio-book) and text-only versions of the "Emilia Galotti" book by G. E. Lessing. For the model that uses exclusively the textual version of the book they first implemented a naive lexicon-based approach followed by a more complex approach that enhances the lexicon by means of several NLP methods to produce sentiment labels (i.e. positive, negative or neutral) for 835 distinct speeches from the book. For the audio model, they leveraged a free version of a popular audio sentiment analysis software to come up with the same set of labels for the audio sequences that had been aligned with the 835 speeches in the textual version of the book. The results of distinct models point in quite different directions: textual models tend to predict the overall sentiment as rather negative while the audio model labels it as rather positive. Compared to the gold standard which was set by a human expert assessor who labelled manually 200 speeches, the textual-based sentiment models achieve accuracies of 52% and 56% for the naive and the more complex approaches respectively, while the achieved accuracy for audio-based model reaches only 31%.

In [14], Poria et al. explore the impact of leveraging multimodal features (in contrast to unimodal features) on the accuracy of predictive models for utterances sentiment classification in video content. They define an utterance as ".. a segment of speech bounded by breaths or pauses", and as a first step extract unimodal features for each one in the observed corpus of videos (i.e. textual features, audio features and visual features). To this end, they utilize publicly available open-source toolkits and models (e.g. openSMILE

and Google word2vec) as well as custom-made Convolutional Neural Networks (CNN). They then obtain models by using different variants of Long Short-Term Memory (a variant of the Recurrent Neural Network architecture) networks, with and without the attention mechanism (which is, in essence, able to assign higher importance to the utterances most relevant in the context of currently observed one) and by using unimodal as well as different combinations of features extracted from all modes. Their results indicate that context of utterances (which had been largely considered independent until then) contributes significantly to the predictive power of obtained models, and report the macro F-score (a measure of accuracy) of 81.3%, which represented an improvement in the range 6.25%–7.5% over the current state of the art.

Majumder et al. in [15] propose a hierarchical fusion strategy in which they first fuse modalities two by two and only then proceed to fuse all three resulting combinations (stemming from text, visual and audio modalities). They use a very similar approach to extract unimodal features as [14], dimensions of which they then equalize prior to performing pairwise modalities fusion. In the modelling stage, they incorporate information from the surrounding utterances by employing Gated Recurrent Units (GRU) to model the context, which allows them to take into account the semantic dependence among the utterances in videos. In this way, they were able to improve the existing classification results and obtain a new state of the art by reaching up to 2.4% higher macro F-scores in sentiment analysis and emotion recognition tasks measured on domain-standard multimodal datasets.

To try and improve further the accuracy of multimodal sentiment analysis based on audio and textual sources alone, Chen et al. [16] proposed a model called Deep Feature Fusion - Audio and Text Modality Fusion (DFF-ATMF), which leverages both multi-feature and multi-modality fusion. In the audio modality branch, they use a combination of Bidirectional LSTM networks with attention mechanism and a CNN to concatenate raw audio waveform and acoustic features (multi-feature fusion), which they later fuse with the features extracted from textual modality (extracted via similar architecture but relying on the Bidirectional Encoder Representations from Transformers – or BERT – to pre-train text feature representations). This approach, when applied to the audio and textual features of the CMU-MOSI [17] dataset (the same one used in the studies previously described) managed to outperform all others by a margin of 0.3% in terms of the macro F-score. Simultaneously, the authors tested the performance of the proposed approach on other standard datasets where they were able to achieve even more considerable differences in their favour.

Kumar et al. in [18] created a hybrid deep learning model for fine-grained sentiment prediction in real-time multimodal data (which in this case refers to the potential availability of two modalities: either visual, textual or both, such as frequently encountered in posts on social networks or infographics). In their approach they propose two separate branches for visual and textual content detection and analytics (that leverage both lexicon and CNN-based approaches to extract features), which converge in the Boolean decision system module that uses the logical OR operator to ultimately produce the output in the form of one out of the possible five fine-grained sentiment categories: ‘highly positive,’ ‘positive,’ ‘neutral,’ ‘negative’ and ‘highly negative’. The proposed

model achieved sentiment classification accuracies of around 88%, 75% and 91% for text, image, and infographic (i.e. both) data modalities respectively.

A Multimodal Correlated Network for emotion recognition aiming at exploiting the information from both audio and visual channels to achieve a more robust and accurate detection is presented in [11]. They used a 2D-CNN for extracting audio features and a 3D-CNN followed by an LSTM for extracting video features while simultaneously capturing the temporal information present in them. The feature learning process of different modals is guided by a correlated loss function and the obtained features are fused by using a weighted concatenation approach. The proposed method was able to achieve the highest average accuracy of 60.59% in recognizing seven emotions present in the dataset they used, which meant it overperformed most other states of the art models.

Finally, Chen et al. in [19] tackle the issue of distinct modalities providing variable information value over time by proposing a multimodal fusion strategy named conditional attention fusion which can dynamically pay attention to different modalities at each time step. Their approach allows assigning weights to different modalities that are not fixed but rather automatically decided by the current input features and recent historical information. In addition, instead of predicting distinct emotional labels, they use valence and arousal as target variables and report a lower Root Mean Square Error of their approach for valence prediction compared to competing models.

4 Conclusion

Technological advancements over the last couple of decades have caused devices of various kinds to be more and more present in the daily life of people. Even though their main purpose is to help users perform different tasks more easily or efficiently, failure to do so may provoke negative reactions and cause frustration and anger within their owners [20]. The field of affective computing aims to help with the development of systems and devices able to recognize, process, interpret and react in a human-like fashion that should ultimately allow machines to exhibit a kind of emotional intelligence indistinguishable from the one humans possess. Currently, a lot of research efforts in this area are oriented towards reliably detecting sentiments or recognizing emotions in various kinds of digital content. Given that the content created, published and shared online nowadays is more often than not multimodal in nature, scholars are attempting to leverage different channels of communication (namely visual, audio and linguistic) to derive proper context from it and deduce emotions and sentiments present correctly. This is particularly important considering the fact that human perception of different potential measures of interest (e.g. subjective video quality) might be affected by the actual content presented [21] and emotions it triggers, which can have significant implications in many real-world use cases.

Most promising contemporary modelling approaches in affective computing invariably rely on machine learning and deep learning techniques to derive informative features from the content observed and map them robustly to target concepts. Literature survey has shown that multimodal methods consistently outperform unimodal ones, demonstrating the synergistic effects of using information obtained from one modal in the context of features of another. Even though there is still much room for improvement, promising

results of these nascent efforts show that proper automatic sentiment analysis and emotion recognition is attainable which should help alleviate some of the concerns in the domain of human-machine interaction and lead to numerous novel practical applications in different fields of science and technology.

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Business Process Management and E-Government Systems

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Abstract. Business Process Management Systems (BPMS) can be applied in the E-government domain to successfully identify, analyze, redesign, and automate an e-government process, without losing the constitutional principles and making them less bureaucratic. The positive outcomes could be numerous, such as public sector performance enhancement, cost reduction, or analysis of the event data that the BPM engine generates. This paper aims to discover how BPMS and E-government systems can be integrated. A systematic literature review is conducted, focusing on the goals for the development of such systems, as well as on the implemented Information and Communication Technologies (ICTs).

Keywords: E-government · Business Process Management Systems · Workflow engine

1 Introduction

The technological support for E-government projects has evolved in the last two decades, together with the maturity levels of most E-government systems. Contemporary and mature E-government systems aim to achieve interoperability, integration, and data exchange between different government agencies by using Information and Communication Technologies (ICTs). One of the defined obstacles for achieving seamless integration of E-government services is their lack of automation through workflows and Business Process Management Systems (BPMS) [1, 2]. BPMS is a domain-agnostic Process-Aware Information System (PAIS), meaning BPMS should support the design, analysis, execution, and monitoring of previously modeled business processes [3]. If E-government services are standardized, modeled as business processes, and supported by a BPMS, they can be synchronized and put together to form a one-stop E-government system. Furthermore, BPMS have a specific architecture and enable interaction with external services.

Most research in the field of E-government focuses on the critical success factors of implementation, as many early developed E-government projects failed due to the low intention to use and user satisfaction with the system. One research proved that the quality of the information system and the provided information has a positive influence on the user satisfaction and the intention to use the system [4]. The utilization of BPMS in the development of the E-government system could increase the overall system quality

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 526–534, 2022.
http://doi.org/10.1007/978-3-030-97947-8_69

and, therefore, positively influence the system's success. This paper aims to discover how are particular architectural components of BPMS combined with external services in the field of E-government. Although BPMS is used to enhance the performance of E-government systems for over a decade, there is no extensive literature review on their combined implementation. A systematic literature review is conducted among papers describing different frameworks or applications of BPMS in the E-government field, with the focus on the ICTs that were combined with the BPMS and their overall collaboration.

The remainder of the paper is organized as follows. Section 2 elaborates on the basic concepts and applications of BPMS and E-government. Section 3 presents a systematic literature review methodology, results, and discussion. Section 4 concludes the paper.

2 E-Government and BPMS

E-government was developed with the incentive to offer integrated online data and transactional electronic services to citizens, businesses, and other government bodies, with the use of ICTs. The expected benefits of E-government systems are the reduction of costs, improved performance, and efficiency [5]. The development of E-government systems is conceptualized through maturity stages, of which the most known maturity model is defined by Layne and Lee [6]. They defined four stages of maturity for E-government are:

- Cataloging – Online presence, downloadable forms;
- Transaction – Online services;
- Vertical integration: Local and higher-level systems are integrated;
- Horizontal integration – Systems are integrated across different functionalities and presented through a one-stop government portal.

Trends in the development of E-government systems are modeling, automation, and monitoring of e-services that are being offered to citizens and businesses, as well as contemporary ICTs such as cloud computing, open data, e-participation and business collaboration [7]. How a government will implement these ICTs depends on the system users ICT readiness and on the available infrastructure. In the context of this paper, E-government trends regarding the application of BPMS will be further analyzed.

BPMS architecture consists of an execution engine, process modeling tool, worklist handler, and integrated external services [3]. Execution engines can call an external service, i.e., an external application that automatically performs a task. In the context of E-government, Business Process Management (BPM) engine (workflow engine, execution engine) can be configured and adapted to enable high productivity low-coding government business process automation. The benefits of such implementation are that any changes to the requirements of the process have to be accommodated by changing a BPMN standardized model with no coding, and government legislation can be implemented through work patterns and business rules [8, 9]. Moreover, governments can benefit from successful identification, analysis, and redesign of an e-government process using BPM techniques without losing the constitutional principles and making them less bureaucratic [10].

3 Systematic Literature Review

The first step in conducting a systematic literature review is determining the need for a review on the proposed topic. The application of BPMS in the E-government domain has not yet been formally reviewed, therefore a need for the synthesis of information from published papers arrises. The following subsections describe the defined research questions, search strategy, inclusion and exclusion criteria, the review process, as well as the results and the findings.

3.1 Planning and Conducting the Review

The goal of this review is to gather information about the relationship between BPMS and the E-government. Accordingly, the following research questions were formulated:

RQ1: What are the goals of BPMS and E-government systems integration?
RQ2: What technologies and components do these systems integrate?

To find the relevant research papers, the SCOPUS and Web of Science databases were searched. The search term was "business process management" AND e-government. The search resulted in 68 papers on Scopus and 32 papers on Web of Science, where most papers were the same. The limitation on the publication year was not set in order to extract more comprehensive results. The inclusion criteria were the following:

IC1: The paper has to present an e-government system that utilizes a BPMS.
IC2: The paper has to be written in English.

The exclusion criteria were the following:

EC1: Duplicate papers found in different databases should be removed.
EC2: If one author has more than one paper regarding the same work, only one paper will be included in the review.

After applying inclusion and exclusion criteria on the titles and abstracts of the papers, 19 papers fit the set criteria. However, 14 primary studies were obtained.

By defining the data extraction strategy, the features that will be extracted from each primary study were determined. Publication type and publication year will be analyzed to gain insight into when and where this topic was most analyzed and published. A type feature will determine whether the publication presents a new framework, tool, architecture, or a case study. The goal of the publication will be extracted to understand the problems in the field better. Furthermore, ICT feature is the most meaningful one, as it will contain information about specific ICT used in the application of BPMS in the E-government domain.

3.2 Review Results

This subsection presents the results of the data extraction phase. How these results answer the research questions will be elaborated in the Sect. 4. Discussion subsection.

Figure 1 presents the types of publication by year. Conference proceedings make the majority of the analyzed papers, with 71%, and journal articles take 29%. In the years 2003, 2004 and 2005 there was a peak in the number of published papers on the topic, and again in the year 2020. Furthermore, studies can be divided into two groups, as there are no analyzed papers between the years 2008 and 2016. In the discussion subsection, the difference between these two groups of papers will be discussed.

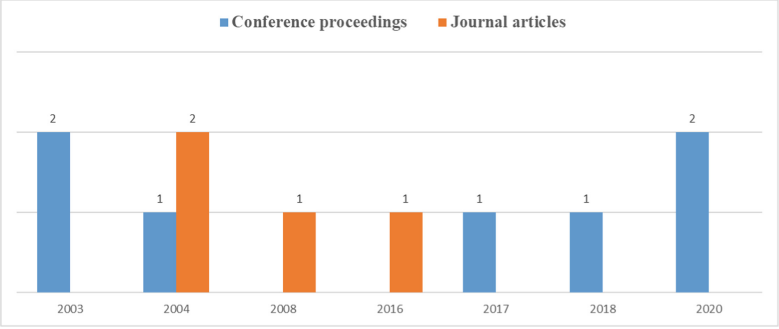

Fig. 1. Publication types by year

Figure 2 presents the distribution of primary studies contributions. Primary studies were divided based on what they were proposing, such as a new architecture [11, 13–15, 21], a new way of application of existing technologies without the definition of a specific framework or architecture [16, 22, 23], a new framework [18, 19], a developed tool or a prototype [17, 20], a new platform [12] or a metamodel [24].

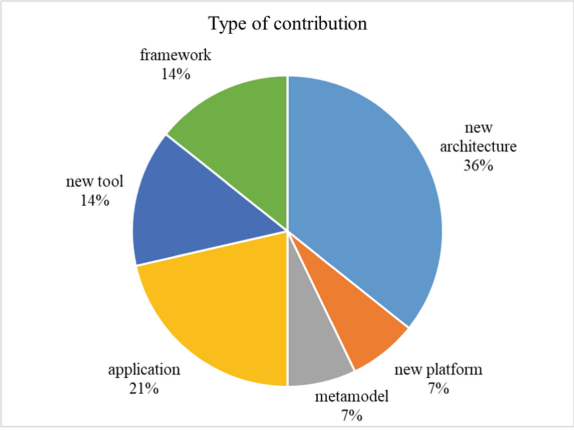

Fig. 2. Types of paper contribution

After analysis of the selected papers, several research goals were detected and presented in Fig. 3. The most stated goal was integration, found in 31% of the analyzed

papers [14, 16–18, 21], regarding the integration of E-governments services. The following are interoperability [11, 19, 24], found in 19% of the papers, and rapid development [12, 19] found in 13% of the papers. The remaining goals were found in 6% of the papers (only one paper per goal), i.e., data exchange [13], security [15], process monitoring and improvement [22], process compliance [23], improving the collaboration of business processes [24], and process automation [20].

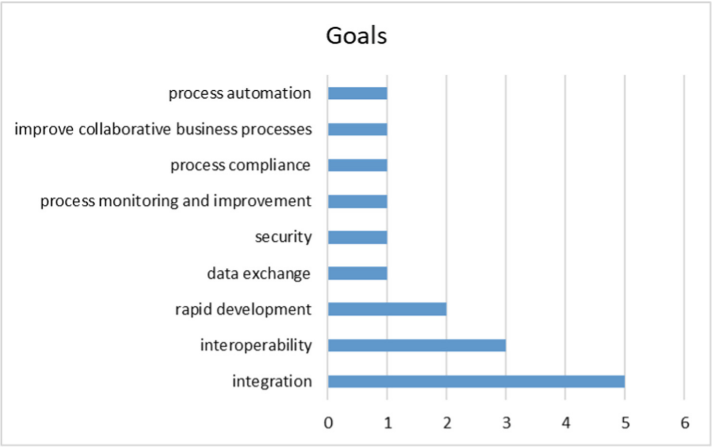

Fig. 3. Goals of the proposed solutions

Table 1 is a matrix where rows contain used ICTs in primary studies, and columns contain primary studies references. By arranging the primary studies chronologically, trends in the utilization of different ICTs during different periods can be detected.

Table 1. ICTs utilized in primary studies

ICTs	References													
	2002	2003		2004			2005		2008	2016	2017	2018	2020	
	17	20	21	13	18	19	15	16	14	22	12	11	23	24
Workflow engine	x	x	x	x	x	x	x		x		x	x	x	x
SOA	x	x		x		x				x			x	
Software agents		x	x		x				x					
Government portal		x						x		x				x

(*continued*)

Table 1. (*continued*)

ICTs	References													
	2002	2003		2004			2005		2008	2016	2017	2018	2020	
	17	20	21	13	18	19	15	16	14	22	12	11	23	24
Collaborative environment			x										x	x
Enterprise service bus												x		x
Compliance control system													x	x
Bussines rule engine								x						
Process engine										x				
Government cloud platform											x			
Role-based access control											x			
Complex event processing														x

4 Discussion

This subsection will further discuss the results presented in the previous chapter and elaborate on how the results answer the research questions.

RQ1 - What are the goals of BPMS and E-government systems integration? Fig. 3 presented the goals of the analyzed primary studies, together with the information about their frequency. Integration is one of the most pursued outcomes in the E-government domain, i.e., seamless integration of computer-supported government services. Some approaches with this goal aimed to apply BPMS for the management of cross-border workflows that span across multiple European chambers of commerce and industry [14]. Others aimed to integrate the E-government services with a business rule engine [16], workflow engines and SOA [17, 18] and integrate the higher levels of public administration with the Computer Supported Collaborative Environment [21]. Interoperability, the second most detected goal, facilitates the seamless exchange of information between information systems across sectors of government. The extracted data shows that the primary studies that aimed for interoperability, published in the years 2018 and 2020,

implemented some type of a workflow engine, SOA, and integration or Enterprise Service Bus [11, 24]. It can be concluded that system interoperability is easier to achieve with contemporary ICTs.

RQ2 - What technologies and components do these systems integrate? The matrix in Table 1 presented the most commonly used ICTs, with a workflow engine (process engine) being utilized in 93% of the primary studies and Service-Oriented Architecture (SOA) in 43% of the primary studies. ICTs are sorted by the frequency of their application, and the primary studies are chronologically ordered. It can be concluded that from the year 2016, ICTs and concepts such as Enterprise Service Bus, Compliance Control System, Government Computer Cloud, Role-based access control, and complex event processing were not used. A collaborative environment is also an ICT that is being more frequently used in the contemporary E-government systems.

5 Conclusion

Presented paper reviewed the literature on the BPMS integration with the E-government systems. BPM, in general, can be successfully applied in the field of E-government, by discovering, redesigning, and finally automating government processes. Furthermore, it is concluded that the possibilities and functionalities of BPMS correspond to the current needs of E-government systems, such as service integration and inter-organizational collaboration. The results showed that the main goals of these types of E-government systems are integration, interoperability, and rapid development. Different ICTs that have been used together with the BPMS have been detected and presented through a matrix. ICTs such as SOA and workflow engines have been used in the early 2000s, and new technologies are being implemented in the last years, such as cloud technologies, collaborative business processes, and compliance control systems. As the systematic literature review included 14 primary studies, the scope of the research can be broadened to make more accurate conclusions. Furthermore, the relationship between ICTs and detected goals can be tested to discover how specific goals influence the selection of ICTs.

Acknowledgement. This research (paper) has been supported by the Ministry of Education, Science and Technological Development through the project no. 451–03-68/2020–14/200156: "Innovative scientific and artistic research from the FTS (activity) domain".

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Business Process Management Improvement and a New Model for Performance Management

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Abstract. In business strategy creating, a successful company measures the effectiveness of running business processes, analysing and identifying elements that substantially contribute to creating competitive advantage and ensuring long-term growth and development of the company. In emphasizing the competitive advantage, and thus the growth and development of the company, it is necessary to develop a model of continuous quality improvement that is based on a high degree of customer satisfaction, and continuous measurement and analysis of the business processes performance. Based on analysis of companies in the region it was explored how companies are organized and the extent to manage the performance of their critical business processes. The new method based on the created model is made in LabVIEW software and tested in industrial company where managers assessed the value and importance of defined KPIs in four areas: effectiveness, efficiency, cost reduction and performance during one year. The program calculates results and gives information about KPIs including graphical displaying. The new model gives managers possibility to compare results, measure performance and create business strategies. The results of business process measurement and business analysis serve to better decision-making about possible changes in business and operating model, which affects faster, more efficient, more economical and quality execution of business processes.

Keywords: Business processes · Performance management · KPIs

1 Introduction

Companies are forced to operate in accordance to trends and change their business strategies according to market conditions, as well as to measure performance constantly and analyse KPIs, that is how they would change their business in accordance to the key parameters in order to achieve effective and efficient operating. Modern business conditions are characterized by constant changes and rapid technological development, which have influenced the increase in the intensity and speed of changes, as well as the complexity of the problems that occur in a certain business [1].

Since in the current period of global economic crisis in which opportunities for increasing profit are very low, industrial companies are faced with a need to find a

B. Lalic et al. (Eds.): IS 2020, LNMUINEN, pp. 535–543, 2022.
http://doi.org/10.1007/978-3-030-97947-8_70

solution for organizing effective and efficient business processes with constant reduction of costs. Managing production in production systems is not possible without relevant, timely and reliable quality information about the state of a certain system and its behavior. Because of that, it is of importance that all business processes are managed. [2]. In order to maintain a business and its competitiveness in the specific circumstances, it is very important for companies to use appropriate methods and measurements. In order to define strategies and accomplish objectives for achieving a better performance, management has to define and measure key performance indicators (KPIs) that refer to effectiveness and efficiency and to assess the success of company performance. Practical part of the research is related to the application of theoretical basis in practice, implementing the new model and creation of the software solution for performance analysis of international industrial companies by measuring defined KPIs. Data collection will be conducted by survey and will refer to the assessment of the impact of KPIs to reducing total costs, as well as the effectiveness, efficiency and performance of industrial companies within four defined perspectives.

2 Theoretical Background

The research is based on analysing values and importance of KPIs regarding effectiveness, efficiency, cost reduction and performance. A natural measure of performance is a productivity ratio: the ratio of outputs to inputs, where larger values of this ratio are associated with better performance [3] and KPI is a number or value which can be compared against an internal target, or an external target "benchmarking" to give an indication of performance [4].

Developing performance metrics starts by grouping the organizations resource-gathering and disbursing activities into five clusters: inputs, activities, outputs, outcomes, and impacts [5] where measures of outcomes are an insufficient mechanism for controlling performance [6]. Many researchers analysed and linked specific nonfinancial measures to financial performance [7–9]. Modern business environment as extremely unpredictable, dynamic and complex, which imposes the need to apply the criteria of non-financial efficiency of the company [10]. The performance measurement models evolved from a cybernetic view whereby performance measurement was based mainly on financial measures to a holistic view based on multiple nonfinancial measures [11]. Performance measurement is thus implicitly linked to the notion of diagnostic control systems, described as formal feedback systems used to monitor organizational outcomes [12]. Holistic view of performance measurement encompasses several uses that have been summarized by means of five elements: decision-making, control, signalling, education and learning as well as external communication [13].

An essential requirement for tracking set goals' fulfilment is a suitable choice of performance indicators for assessment of production performance [14]. Effectiveness is an important concept in management literature and it has always measured how successfully organizations achieve their missions through their core strategies [15]. Some focus on internal organizational factors when defining criteria of performance, such as organizational goals or the procedures for accomplishing these goals [16].

The connection between this research and previously published work within engineering management is based on performance measurement in organization [17] and strategic management using action plans and defined variables [18].

2.1 Objectives and Hypotheses

Research objectives can be defined as follows:

Objective 1: Development and scientific description of a new model for analysing and measuring the impact of defined KPIs on effectiveness, efficiency, cost reduction and company performance in the four functional areas.
Objective 2: Acquiring the necessary information for organizing efficient production with minimum costs and gathering knowledge of the KPIs values based on which strategies for industrial companies can be created.

Hypotheses in accordance with the aim of the research can be defined as follows:

Hypothesis 1: Concretization and definition of goals of industrial companies can be analysed by creating a model in which the main functional areas of the company are defined as well as KPIs within the defined areas, and by assessing the KPIs with the aim to help managers in business analysis and strategies.
Hypothesis 2: It is possible to create a software solution for the analysis of defined KPIs, which includes their importance and value for effectiveness, efficiency, cost reduction and the performance during a defined period of time, with calculating mean values and presenting results with graphs.

3 Methodology

New model is developed using software LabVIEW that allows the creation of application-specific templates (sub-virtual instruments) with the aim to reduce the production time for the identical subjects [19]. LabVIEW, which stands for Laboratory Virtual Instrumentation Engineering Workbench is a graphical programming language first released in 1986 by National Instruments and implements a dataflow paradigm in which the code is not written, but rather drawn or represented graphically similar to a flowchart diagram [20].

The National Instruments LabVIEW software is a graphical programming language used extensively in research and industry. Created to help in the design of programs, the LabVIEW software provides an extensive library of functions and tools for data analysis, report generation, data acquisition and file input/output and similarly [21]. LabVIEW is a highly productive development environment for creating custom applications that interact with real-world data or signals in fields such as science and engineering [22] and using LabVIEW graphical programming [23]. With the aim to analyse industrial company performance more precisely, in this model industrial company is divided in four main functional areas: Marketing and Sales, Logistics and Manufacturing, Finance and Accounting and Human Resources. Within defined areas KPIs are defined and the impact of each of the KPIs on the objective of industrial companies can be determined [24, 25].

This model contains sixty KPIs and there are fifteen KPIs within each functional area that represent the most important parameters in that sector which have influence on cost reduction and company performance, and a significant number of them describes efficiency or effectiveness.

4 Model Description

Model for performance management contains company goal (marked with 1), four sectors in company (marked with 11, 12, 13 and 14) and KPIs within sectors marked with the number of the sector and number of KPI (111–1115, 121–1215, 131–1315 and 141–1415), as it is presented in Table 1. The method created in software LabVIEW contains defined KPIs within sectors as it is presented in Table 1, and managers of each sector assess KPIs according to their importance and value.

Table 1. KPIs within four main sectors in industrial company

Efficient production with minimal costs (1)	
Marketing and Sales (11)	Logistics and Manufacturing (12)
The share of sell orders executed at time (111)	Ratio of realized orders and deliveries (121)
Customer satisfaction index (112)	Scarp rate (122)
Index of number of new customers during the period (113)	Overall efficiency of technological systems (123)
The index of quality of sold products (114)	Preparatory - final time (124)
Index of contacts realization with customers (115)	Quality of transport (125)

(*continued*)

Table 1. (*continued*)

Time from investment to cash collection (116)	Low transport costs (126)
Company's reputation on the market (117)	Defects per million opportunities (127)
Reducing the number of customers (clients)	The percentage of damaged goods after delivery (128)
The attractiveness of products to potential customers (119)	Reliability of logistical support (129)
Recognition of the company's brands on the market (1110)	Mean time between failures (1210)
Percentage of saved customers in the last 3 years (1111)	The time required for inventory turnover (1211)
Image of the company on the market (1112)	The overall efficiency of equipment (1212)
Customers loyalty to the company (1113)	Average costs of production items (1213)
The growth of the total number of customers (users) (1114)	Reduction of costs of new product development (1214)
The growth of the company market share (1115)	Reduction of imported materials (1215)
Finance and Accounting (13)	Human Resources (14)
Return on investment (131)	The efficiency of employees (141)
Inventory turnover ratio (132)	Professional expertise of employees (142)
Turnover ratio of total assets (133)	Motivation of employees (143)
Profit per product (134)	Effective business collaboration in company (144)
Net income (135)	Intellectual capital (145)
Low salaries (136)	Innovations from the employees (146)
Low level of investment (137)	Education of employees (147)
Liquidity index (138)	Know- how (148)
Return on equity (139)	Corporate culture (149)
Revenue per employee (1310)	Competent external partners (1410)
Return on investment time (1311)	Average employees professional experience (1411)
Profit per unit (1312)	Patents and licenses (1412)
Income taxes (1313)	Design rights (1413)
The average salary per employee (1314)	Entrepreneurial employees (1414)
Earning per project (1315)	Professional qualifications of employees (1415)

5 Findings

The new method was tested on the practical example and the survey was conducted in industrial company that operates in the global market and has production points on different locations. Managers of four sectors filled the survey during one year assessing KPIs in the software LabVIEW. Every KPI is assessed in the way it is presented for KPI Quality of transport, as shown in Fig. 1:

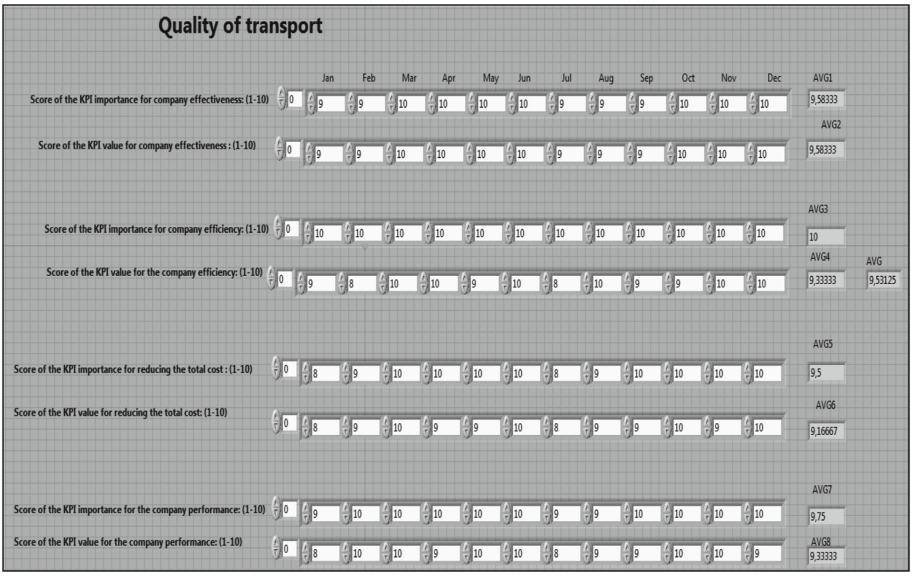

Fig. 1. Analysis for KPI quality of transport

As it can be seen above, managers fill marks and the software calculates average scores for values and importance of effectiveness, efficiency, reducing total costs and company performance. By analysing these values, it can be concluded that the highest average value (10) is given for importance of the KPI for company efficiency, which confirms the fact that Quality of transport is very important for efficiency. Analysing average value for company efficiency, the result is lower (9,3333), especially for February and July where the marks are 8, so managers have to pay attention on causes of such low marks and make some changes.

The other results for Quality of transport can be discussed in the same way, and manager have to pay attention to all lower marks in order to improve the results in future analysis. Average marks for all scores of importance are equal or lower than for values, so it can be concluded that the KPI is very important but the values could be higher, which means that quality of transport should be better and managers have to analyse which factors influence these results and solve the problem.

The complete average score for the KPIs is 9,53125 and some new strategies should be created in order to get better results. The same analysis is made for all other KPIs and the software calculated the average score results.

Final report for the whole company with four sectors and all sixty KPIs contains the calculated mean values and the results are presented in the Final report in Fig. 2:

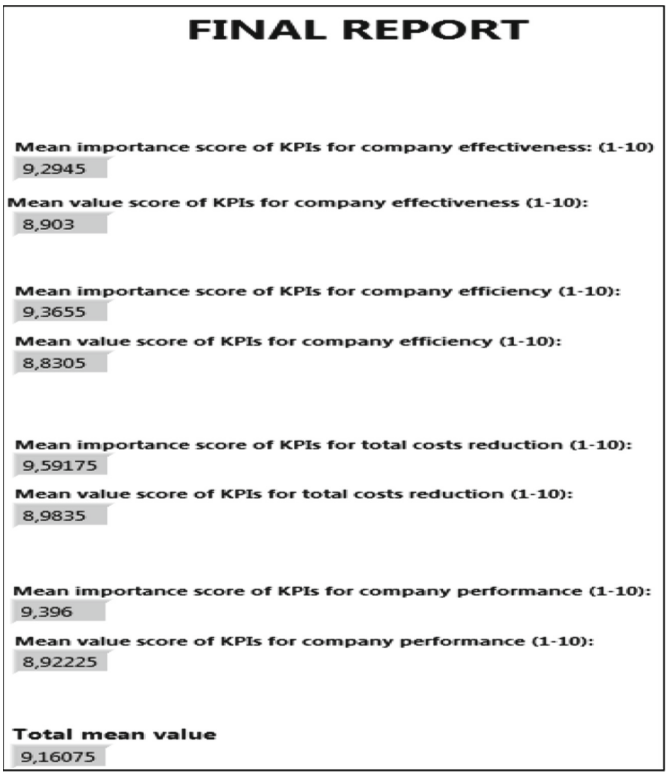

Fig. 2. Final report for the whole company

As it can be seen above, Total mean value is high (9,16075), so all defined KPIs have high influence on the company goal, efficient production with minimal costs.

All mean importance scores are high (9,2945, 9,3655, 9,59175 and 9,396) which means that managers assessed all KPIs as important for the defined criteria, but all mean value scores are lower (8,903, 8,8305, 8,9835 and 8,92225) which indicates that values are not high for all KPIs as importance, so an analysis of KPIs with low values should be conducted and according to the results, new strategies created in order to improve them. Managers have the possibility to view graphical displays of mean value scores and mean importance scores in order compare results easier.

Results of total mean values for defined sectors as functional areas and the whole company are calculated based on all mean values of sixty KPIs. Total mean value for the whole company is 9,5795 which means that all KPIs have significant values and importance for the company goal including all defined criteria. Analysing total mean values of sectors it is observed that the highest value has the sector of Human Resources which means that in this sectors all KPIs have high marks for importance and value and

their influence on the company goal is the highest. Based on this result, company has to pay attention to KPIs from this sector in order for its values not to become lower. Total mean value for Marketing and Sales is also high (9,689), as well as for Finance and Accounting (9,733) and for Logistics and Manufacturing is the lowest (9,029) which means that these sectors need analysis of all KPIs and their values for each month, so that managers could be able to remove causes of these results and change business strategies.

6 Conclusion

Innovative method for analysis KPIs created in LabVIEW software shows that all analysed KPIs have significant influence on the effectiveness, efficiency, total costs reduction and performance. On the basis of the research in industrial company, obtained results are the lowest in the sector of logistics and manufacturing, but unlike other sectors their value vary, which offers the possibility of improvement. Based on these results it is proposed to create strategies related to changes in the sector of logistics and manufacturing, because it is necessary to pay attention there to every KPI and each time period to detect opportunities to improve performance in this area. Within the research, hypotheses were proved in the following way:

Hypothesis 1: The research has proven that concretization and definition of goals in the industrial companies can be analysed by creating a model and defining the main functional areas. Within these areas the most influential KPIs are defined and assessed, so managers can obtain important results which can help them in business analysis and creating strategies.
Hypothesis 2: The research has also proven that it is possible to create new method for the analysis of defined KPIs as a new tool in LabVIEW software. The tool includes meassures of importance and value of KPIs that have influence on effectiveness, efficiency, cost reduction and company performance.

The survey confirmed the set objectives and defined KPIs can influence development strategies and help in organizing efficient processes with minimal costs.

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http://doi.org/10.1007/978-3-030-97947-8